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ABSTRACT

Perspectives on the conditions of academic research facilities and the various funding mechanisms proposed for modernizing them are offered in this report on the University Research Facilities Revitalization Act of 1985 (H.R. 2823). Major components of this bill include: (1) the creation of a university and college research laboratory modernization program in each of the six leading federal Research and Development (R&D) agencies; (2) an authorization of start-up funds for the programs and changes in R&D agency budgets for systematic facility renewal; (3) provisions which assure that large, well established research universities are not favored over smaller or newly emerging academic institutions; (4) plans for cost-sharing programs with federal contributions of approximately 5 billion dollars over ten years and 5 billion in nonfederal funds; and (5) use of a program of matching federal grants. Testimonies addressing these issues and the impact of research facilities on the quality of academic research and science education are presented. (ML)

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H.R. 2823—THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

FIRST SESSION

JULY 30; OCTOBER 22, 24, 30, 1985

[No. 63]

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H.R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

TUESDAY, JULY 30, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:45 a.m., in room 2318, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Mr. Walgren. Let me call us to beginning. Today the Subcommittee on Science, Research and Technology holds the first of a series of hearings on what is known as the University Research Facilities Revitalization Act of 1985, designated H.R. 2823.

Today's hearing will provide us with a general perspective on the condition of academic research facilities and the various funding mechanisms proposed for modernizing them. We are particularly interested in an assessment of the approach embodied in this particular bill, that has been introduced by Mr. Fuqua, the chairman of the full Science and Technology Committee, which would establish a 10-year Federal program of matching grants focused on the six leading research and development agencies in the Federal Government.

There certainly seems to be a general, increasing concern that academic research facilities are in a state of either disrepair or obsolescense. The current situation, in many instances, certainly threatens the quality of academic research and scientific education in general. And there are many that are very concerned that unless we take immediate and sustained action in this area, we will suffer irreversible losses of opportunities that might be ours.

The United States academic community has certainly achieved a high level of excellence in the conduct of scientific research, and it's clearly in the national interest for that excellence to be maintained and for us to take as full advantage of whatever capabilities we have in that area, or can have in that area, from the standpoint of both international economic competition and certainly the national security.

There is no way that that level of excellence, that would serve our Nation best, could be sustained without first-class facilities and without the personnel that are related to first-class facilities. And it seems relatively obvious that our standing in the scientific race and our progress in science in general is very dependent on the physical state of academic research facilities.

We're fortunate to have with us today three witnesses who each have a special expertise on the research infrastructure. The first witness will be Congressman Fuqua, the chairman of the full Science and Technology Committee, and the proponent of H.R. 2823. He will describe his proposal and viewpoint on this issue. As all of you know, Chairman Fuqua has a longstanding record in this area, and represents a major resource in the Congress with respect to science and technology.

Second, Dr. Bernadine Healy, the Deputy Director of the Office of Science and Technology Policy, has played a key role in working in this area in the OSTP, and most recently has been involved in a special working group of the White House Science Council.

And our third witness, Dr. Frank Press, who, as you know, is the president of the National Academy of Sciences, and a former Presidential Science Advisor, will be able to describe past Federal efforts in this area, and present the activities and views of the Academy in this area.

As a committee, we want to express our appreciation to those witnesses for their effort in being resources to the committee, and for offering us their views and their work product. And we hope that from that, as a Congress, we will be able to develop the most constructive response.

And with that, I'd like to recognize the first ranking member from the minority side of the committee, Manuel Lujan, from New Mexico. Any opening comments?

Mr. LUJAN. I have no opening questions. I would like to compliment the chairman on this bill and his hard work on this program. Thank you.

Mr. WALGREN. And then we are joined today by Congressman Mike Andrews, from Texas, who serves on the Appropriations Committee?

Mr. ANDREWS. Science and Tech——

Mr. WALGREN. Yes, OK. And who has been particularly interested in the facilities question, and we're very happy to have him sitting with us today. And let me recognize you, Mike, for any opening comments you would like to make.

Mr. ANDREWS. Thank you very much, Mr. Chairman. I really appreciate the opportunity to participate in this hearing today, and I want to express my full support for this important piece of legislation and certainly compliment Chairman Fuqua for his insightful leadership and taking such a strong position in this area for a long period of time.

In support of the bill I would like to just relate, for the purposes of the record, some telling information about the critical need for renovation and research in my own State of Texas. In 1982 the coordinating board of Texas colleges and universities studied this very problem and determined that the State would need as much as $20 million to bring the State's public research facilities to a satisfactory level of repair. And by satisfactory, the Board did not mean state of the art, it meant simply keeping the roofs from leaking on the labs.

In a similar study that was done by the Texas Society of Professional Engineers on the need for newer research instrumentation in Texas institutions, they saw a critical need for newer facilities and equipment to train the next generation of scientists and engineers. They estimated that Texas private and public research facilities would need approximately $100 million simply to renovate their existing machinery and equipment.

To give you some idea of the aging of our facilities in the State of Texas, they currently have an electron microscope facility that was installed in 1960. This is hardly state of the art. They have a liquefier apparatus that was put in place in 1946. And when it's oiled sufficiently I think they are able to use it.

These examples only scratch the surface of the problem that not only Texas, but the Nation, faces in this very critical area. If we're to compete in the world marketplace, if we are to remain number one in space and commercialization of space, we absolutely must rebuild and update this critical area of infrastructure.

We really can't train properly the type of young minds, young students for the next generation of researchers if we're not willing to pay the price now to update the infrastructure. We face a crisis of great proportions, and I again applaud Don Fuqua for coming forward with this timely program to revitalize our Nation's greatest research and resource of our country; our ability to know and to learn and to rebuild our technology and infrastructure.

Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Andrews. And also, without objection, we'll insert in the record at this point an opening statement on behalf of Congressman Boehlert, who is the ranking minority member on the subcommittee.

[The prepared opening statement of Mr. Boehlert follows:]

HONORABLE SHERWOOD BOEHLERT

STATEMENT FOR HEARING ON H.R. 2823,
THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
JULY 30, 1985

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTE, TODAY'S HEARING, I BELIEVE, WILL PROVE TO BE A VERY INFORMATIVE AND EDUCATIONAL EXERCISE FOR ALL MEMBERS ON AN ISSUE WITH MANY COMPLICATED SIDES, THAT IS, THE HEALTH OF OUR U.S. UNIVERSITY RESEARCH FACILITIES.

IT IS RATHER FUNDAMENTAL THAT SOUND SCIENTIFIC AND ENGINEERING RESEARCH, REGARDLESS OF WHERE IT IS CONDUCTED, REQUIRES A BALANCE IN HUMAN RESOURCES, INSTRUMENTATION/EQUIPMENT, AND ADEQUATE FACILITIES. WITH THE INCREASE IN ACTUAL BASIC R&D DOLLARS THAT THE FEDERAL GOVERNMENT HAS BEEN INVESTING SINCE THE EARLY '80'S THIS AMOUNTS TO $20 BILLION DOLLARS ANNUALLY SPENT IN CIVILIAN SECTOR, ABOUT $6 BILLION OF WHICH GOES FOR UNIVERSITY RESEARCH. HOWEVER, IRONICALLY, THESE SAME FIGURES: $6-$20 BILLION ARE THE ROUGH ESTIMATES OF THE COSTS NEEDED FOR RENOVATING AND MODENIZING THE UNIVERSITY RESEARCH INFRASTRUCTURE IN THE NEXT 5 YEARS.

SINCE THE PROSPECT FOR INCREASED FEDERAL FUNDING FOR ANY PURPOSE IS UNREALISTIC, WE ARE THEREFORE BEING CHALLENGED TO COME UP WITH SOME

RATHER CREATIVE AND FLEXIBLE FINANCING IDEAS/SOLUTIONS FOR THE UNIVERSITY RESEARCH INFRASTRUCTURE DEFICIENCY.

MR. CHAIRMAN, I INTEND THAT MY REMARKS REMAIN BRIEF, SO I WILL CONCLUDE BY SAYING THAT I RECOMMEND THAT THIS SUBCOMMITTEE REMAIN OPEN TO A VARIETY OF RECOMMENDATIONS TO IMPROVE THE PRESENT STATUS QUO. THE PROBLEM IS A COMPLICATED ONE AND A SOLUTION FOR ONE INSTITUTION COULD BE A HEADACHE FOR ANOTHER. WHILE THE FUQUA BILL HAS ITS MERITS, IT ALSO HAS SOME DRAW BACKS. LET US BEGIN, HOWEVER, BY ESTABLISHING AN ACCURATE AND HISTORICAL ACCOUNT OF THE PROBLEM, AS WELL AS THE VARIOUS DIMENSIONS OF PROPOSED SOLUTIONS. IN THIS WAY, I BELIEVE WE CONTINUE TO GIVE THE CONSTRUCTIVE AND PRODUCTIVE ATTENTION OF WHICH WE SEEK TO GIVE ALL TOPICS OF SUCH GREAT IMPORTANCE THAT THIS SUBCOMMITTE DEALS WITH.

Mr. **Walgren**. And with that, let me welcome you to our subcommittee, Mr. Chairman. We're pleased you're here, and we look forward to your comments in this area.

STATEMENT OF HON. DON FUQUA, A MEMBER OF CONGRESS FROM THE STATE OF FLORIDA, CHAIRMAN OF THE SCIENCE AND TECHNOLOGY COMMITTEE

Mr. **Fuqua**. Thank you, Mr. Chairman and members of the subcommittee. I appreciate the opportunity to appear before you to testify on behalf of H.R. 2823, the University Research Facilities Revitalization Act of 1985, which I introduced in the House on June 20.

As the members of this subcommittee know, research in almost every field of science and engineering is a combination of people and adequately equipped laboratories. Over time, the conduct of research has become more capital intensive, but unfortunately our universities and colleges have underinvested in their research capital base; that is, equipment and facilities.

Why is this? Well, the answer involves a tendency for institutions to put off long-term capital investments in favor of near term priorities, which is in the long run, as we well know, self defeating. This tendency is reinforced by Federal policies for funding research which seem to work against the long-term capital investments.

We should apply the lesson we learned from the deterioration of our Nation's transportation infrastructure, our roads, bridges, railroad tracks, and so forth. Action was needed and there was a clear Federal responsibility, which lead to our recent reauthorization of the Federal Aid Highway Program. We have a similar problem with our research infrastructure.

It is especially acute at our universities and colleges, which perform half of the Nation's basic research and educate our future scientists and engineers. Again, there is a Federal responsibility. The Government funds a major share of all academic research and development and depends on these institutions to maintain our science and technology base. Moreover, there is a history of Government support for research infrastructure.

Several Federal R&D agencies established programs for the construction of academic research facilities after the Soviet launch of Sputnik in 1958. Such programs, although they were uncoordinated, helped build U.S. research capability or capacity in the 1960's, but by the early 1970's the programs were terminated which, in part, has led to the capital deficit that academic institutions now face.

The need today is not only for additional laboratory space, but also for repair and modernization to overcome rapid obsolescence. Estimates of the cost of renovating and modernizing university research infrastructure range from $15 billion to $40 billion. This need has been documented in recent surveys, in testimony at our own committee hearings last year, and again in our current set of Science Policy Task Force hearings. I'm sure you've heard about this problem in your own subcommittee hearings, and perhaps from your own constituents, as Congressman Andrews pointed out.

Just last week I participated in a conference at the National Academy of Sciences on Academic Research Facilities: Financing Strategies. Most participants agreed that there is a serious problem, and they endorse the notion of matching Federal Grant Programs along the lines of the one that I have proposed in H.R. 2823.

Members of the subcommittee have before them, attached to my prepared statement, a fact sheet on the bill and a copy of the bill. Therefore, I won't go into details on the provisions, but rather present some general features.

This legislation would authorize a creation of a university and college research laboratory modernization program in each of the six leading Federal R&D agencies; the National Science Foundation, the Department of Health and Human Services, the Department of Defense, the Department of Energy, the National Aeronautics and Space Administration, and the Department of Agriculture.

The legislation would authorize startup funds for laboratory modernization programs, and would require structural changes in R&D agency budgets in order to provide for a steady systematic investment in university research facility renewal that is now absent from the budget process. This investment would be indexed to the annual level of federally supported R&D performed at our universities and colleges.

The bill gives Federal agencies discretion in how they implement their facility modernization program. The bill avoids prescribing regulations, except that the grants would be competitive. Facility awards may include mixed use of structures, like research and instruction. In any case, these details would be left to the discretion of each Federal agency. The bill contains a key provision which assures that the facility programs do not favor the big, well established, research universities over the smaller or newly emerging academic institutions. And I must emphasize that this is a cost sharing program.

The Federal share in the 10-year program would be roughly $5 billion, which would leverage another $5 billion in non-Federal funds for a total of $10 billion. It is my intention that, by and large, this program is to be funded not with new money, but with funds redirected from elsewhere in the Federal R&D budget. I believe that this is the only realistic in the present budget climate. There is, however, a triggering proviso that gets things started with money new to this program so that the research activity is not cut.

H.R. 2823 authorizes a program of matching Federal grants. There are several other methods for financing facilities. For example, some people prefer the use of the indirect cost recovery associated with research grants. But that would put too much burden on indirect cost accounts. The facilities related portion of the indirect cost is the fastest growing component of indirect costs. Boosting indirect cost recovery rates even higher will lead to a greater friction between university administrators and research faculty.

Further, the indirect cost recovery approach would not provide a mechanism for the emerging universities and colleges to build a research capacity that they aspire to.

The major advantage of matching grants is that they provide up front money, and they leverage non-Federal funding and financing

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arrangements such as State government appropriations or bond issues, improved credit stature for debt financing, joint ventures with industry, or institutional funds and private foundation grants.

I believe that a Federal grant program is absolutely essential to meet the immediate crisis of disrepair, obsolescence, and lack of space. Later, after we catch up with this problem, then perhaps we could rely on the alternative mechanisms for routine maintenance and upgrade. One mechanism that has been discussed for the longer term, that may be attractive, is a Fannie Mae-type corporation that could issue tax free bonds. I think this is something that certainly is not in the immediate future, but maybe we need to explore, and it may have some possibilities. However, I do have some questions about it.

In conclusion, I wish to emphasize that I intend this legislation to be a vehicle to develop consensus within the Congress, within the executive branch, and within the academic community. Therefore, all of the major provisions of H.R. 2823 should be considered open for revision based on further hearings, discussions, and additional fact finding. On the other hand, I am confident that the bill, as presently structured, comes very close to what the Nation needs.

Thank you, Mr. Chairman. I'll be pleased to answer any questions that you might have at this time.

[The prepared statement of Mr. Fuqua follows:]

STATEMENT OF THE
HON. DON FUQUA (D-FL)
AT HEARING ON H.R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985.
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

July 30, 1985

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before you to testify on H.R. 2823, the University Research Facilities Revitalization Act of 1985, which I introduced in the House on June 20th.

As the Members of this Subcommittee know, research - in almost every field of science and engineering - is a combination of people and adequately equipped laboratories. Over time, the conduct of research has become more capital intensive, but unfortunately our universities and colleges have underinvested in their research capital base - that is, equipment and facilities.

Why is this? The answer involves a tendency for institutions to put off long-term capital investments in favor of near-term priorities, which is - in the long run - as we all know - selfdefeating. This tendency is re-inforced by federal policies for funding research which seem to work against long-term capital investments.

We should apply the lesson we learned from the deterioration of our nation's transportation infrastructure - roads, bridges, railroad trackbeds, and so forth. Action was needed and there was a clear federal responsibility - which led to our recent reauthorization of the Federal Aid Highway Program.

We have a similar problem with our research infrastructure. It is especially acute at our universities and colleges, which perform half of the nation's basic research and educate our future scientists and engineers. Again, there is a federal responsibility - the government funds the major share of all academic research and development, and depends on these institutions to maintain our science and technology base. Moreover, there is a history of government support for research infrastructure.

Several federal R&D agencies established programs for the construction of academic research facilities after the Soviet launch of Sputnik in 1958. Such programs, although they were uncoordinated, helped build U.S. research capacity in the 1960's, but by the early 1970's the programs were terminated - which, in part, has led to the capital deficit that academic institutions now face.

The need today is not only for additional laboratory space, but also for repair and modernization to overcome rapid obsolescence. Estimates of the cost of renovating and modernizing the university research infrastructure range from 15 billion dollars to 40 billion dollars.

This need has been documented in recent surveys; in testimony at our own Committee hearings last year; and again in our current set of Science Policy Task Force hearings. I am sure you have heard about this problem in your Subcommittee hearings - and perhaps from your own constituents!

Just last week, I participated in a conference at the national Academy of Sciences on "Academic Research Facilities - Financing Strategies". Most participants agreed that there is a serious problem and they endorsed the notion of a matching federal grant program, along the lines of the one that I have proposed in H.R. 2823.

Members of the Subcommittee have before them, attached to my prepared statement, a fact sheet on H.R. 2823, and a copy of the bill. Therefore, I won't go into detail on the provisions, but rather present some general features. This legislation would authorize the creation of a university and college research laboratory modernization program in each of the six leading federal R&D agencies: the National Science Foundation (NSF), the Department of Health and Human Services (HHS), the Department of Defense (DOD), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the Department of Agriculture (USDA).

The legislation would authorize start-up funds for the laboratory modernization programs, and would require structural changes in the R&D agency budgets in order to provide for a steady, systematic investment in university research facility renewal that is now absent from the budget process. This investment would be indexed to the annual level of federally-supported R&D performed at our universities and colleges.

The bill gives federal agencies discretion in how they implement their facility modernization programs. The bill avoids prescribing regulations, except that the grants would be competitive.

Facility awards may include mixed-use structures (research and instruction). In any case, these details would be left to the discretion of each federal agency.

The bill contains a key provision which assures that the facility programs do not favor the big, well-established, research universities over the smaller or newly emerging, academic institutions.

I must emphasize that this is a cost-sharing program. The federal share of the ten-year program would be roughly 5 billion dollars, which would leverage another 5 billion dollars in nonfederal funds, for a total of 10 billion dollars.

It is my intention that, by and large, this program is to be funded, not with new money, but with funds redirected from elsewhere in the federal R&D budget. I believe that this is only realistic in the present budget climate. There is, however, a triggering proviso that gets things started with money new to this program so that the research activity is not cut.

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The major advantage of matching grants is that they provide "up-front money", and they leverage non-federal funding and financing arrangements, such as:

- state government appropriations or bond issues.
- improved credit stature for debt financing.
- joint ventures with industry.
- institutional funds and private foundation grants.

I believe that a federal grant program is absolutely essential to meet the immediate crisis of disrepair, obsolescence and lack of space. Later, after we "catch up" with this problem, then perhaps we could rely on the alternative mechanisms for routine maintenance and upgrade.

One mechanism for the longer-term that I find attractive is a "Fannie-Mae" type corporation that could issue tax-free bonds.

In conclusion, I wish to emphasize that I intend this legislation to be a vehicle to develop consensus within the Congress, within the Executive Branch, and within the academic community. Therefore, all of the major provisions of H.R. 2823 should be considered open for revision, based on further hearings, discussions and additional fact finding. On the other hand, I am confident that the bill, as presently structured, comes very close to what the nation needs.

Thank you. I would be happy to answer questions at this time.

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99TH CONGRESS
1ST SESSION

H. R. 2823

To assist in revitalizing the Nation's academic research programs by requiring specified Federal agencies to reserve a portion of their research and development funds for the replacement or modernization of laboratories and other research facilities at universities and colleges.

IN THE HOUSE OF REPRESENTATIVES

JUNE 20, 1985

Mr. FUQUA introduced the following bill; which was referred jointly to the Committees on Science and Technology, Energy and Commerce, Armed Services, and Agriculture

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A BILL

To assist in revitalizing the Nation's academic research programs by requiring specified Federal agencies to reserve a portion of their research and development funds for the replacement or modernization of laboratories and other research facilities at universities and colleges.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "University Research Facilities Revitalization Act of 1985".

FINDINGS

SEC. 2. The Congress finds that—

(1) the fundamental research and related education programs supported by the Federal Government and conducted by the Nation's universities and colleges are essential to our national security, and to our health, economic welfare, and general well-being;

(2) many national research and related education programs conducted by universities and colleges are now hindered by obsolete research buildings and equipment, and many institutions lack sufficient resources to replace or modernize their laboratories;

(3) the Nation's capacity to conduct high-quality research and education programs and to maintain its competitive position at the forefront of modern science, engineering, and technology is threatened by this research capital deficit, which poses serious and adverse consequences to our future national security, health, welfare, and ability to compete in the international marketplace;

(4) a national effort to spur reinvestment in research facilities is needed, and national, State, and local policies and cooperative programs are required that will yield maximum return on the investment of scarce national resources and sustain a commitment to excellence in research and education;

(5) Federal agencies, as part of their missions and in partnership with the States, industry, and universities and colleges, must repair the historic linkages between Federal investment in academic research and training and investment in the research capital base by reinvesting in the capital facilities which modern research and education programs require;

(6) each of the major Federal research and development agencies must participate in a sustained government-wide program to revitalize our academic research facilities by making capital investments in the fields of science and engineering essential to its mission; and

(7) the Congress and the Executive branch require adequate and timely information concerning the condition and future needs of university and college research laboratories and equipment.

PURPOSE; ESTABLISHMENT OF UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAMS

SEC. 3. (a) It is the purpose of this Act to assist in revitalizing the Nation's academic research programs through capital investments in laboratories and other research facilities at universities and colleges.

(b) To carry out this purpose, each of the major Federal research and development agencies shall establish and carry out a new university research laboratory modernization program, under which an amount equal to a specified portion of the funds available to the agency involved for research and development awards to institutions of higher education (as provided in titles I through VI of this Act) will be reserved for the replacement or modernization of such institutions' obsolete laboratories and other research facilities.

(c) The university research laboratory modernization program established by a major Federal research and development agency pursuant to subsection (b) shall be carried out, through projects which involve the replacement or modernization of specific research facilities at the universities and colleges involved and for which funds are awarded in response to specific proposals submitted by such universities and colleges, in accordance with regulations prescribed by the head of such agency with the objective of carrying out the purpose of this Act. The regulations so prescribed shall contain such terms, conditions, and guidelines as may be necessary in the light of that objective, but shall in any event provide that funds to carry out the program (as made available to the agency pursuant to title I through VI of this Act) will be awarded on a competitive basis, and that the funds so awarded to any university or college will be in an amount not exceeding 50 percent of the cost of the replacement or modernization involved (with the funds required to meet the remainder of such cost being provided by the institution involved or from other non-Federal public or private sources).

(d) Criteria for the award of funds to any institution for a project under a university research laboratory modernization program shall include—

(1) the quality of the research and training to be carried out in the facility or facilities involved;

(2) the congruence of the institution's research activities with the future research mission of the agency making the award; and

(3) the contribution which the project will make toward meeting national, regional, and State research and related training needs.

(e) As used in this Act, the term "major Federal research and development agency" means—

(1) the National Science Foundation;

(2) the Department of Health and Human Services;

(3) the Department of Defense;

(4) the Department of Energy;

(5) the National Aeronautics and Space Administration; and

(6) the Department of Agriculture.

TITLE I—IDENTIFICATION AND ASSESSMENT OF UNIVERSITY AND COLLEGE RESEARCH FACILITY NEEDS; FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE NATIONAL SCIENCE FOUNDATION

IDENTIFICATION AND ASSESSMENT OF UNIVERSITY AND COLLEGE RESEARCH FACILITY NEEDS

SEC. 101. (a) The National Science Foundation is authorized to design, establish, and maintain a data collection and analysis capability in the Foundation for the purpose of identifying and assessing the research facilities needs of universities and colleges. For this purpose the needs of universities and colleges for construction and modernization of research laboratories, including fixed equipment and major research equipment, shall be documented by major field of science and engineering; and expenditures by universities and colleges for the construction and modernization of research facilities, the sources of funds, and other appropriate data shall be collected and analyzed.

(b) Every two years the Foundation, in conjunction with other appropriate Federal agencies, shall conduct the surveys which are necessary to identify and assess the research facilities needs of universities and colleges as required under subsection (a), and shall report the results to the Congress. The first such report shall be submitted to the Congress no later than September 1, 1986.

(c) When conducting the surveys required by subsection (b) the Foundation shall also collect and assess data on the implementation of the university research laboratory modernization programs being carried out (by the Foundation and by the other major Federal research and development agencies) under the succeeding provisions of this Act; and when reporting the results of such surveys to the Congress it shall also report to the Congress with respect to the implementation of those programs.

FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE NATIONAL SCIENCE FOUNDATION

SEC. 102. (a) There is hereby authorized to be appropriated to the National Science Foundation for the fiscal year 1987, for the specific purpose of implementing and carrying out the new university research laboratory modernization program established by the Foundation pursuant to section 3(b) of this Act, the sum of $100,000,000.

(b)(1) Of the total sum appropriated to the National Science Foundation for each of the fiscal years 1988 through 1996 and available for obligation by the Foundation for research or research and development awards to universities and colleges, an amount at least equal to the minimum amount determined under paragraph (2) shall be reserved for purposes of this Act and used only to carry out the Foundation's university research laboratory modernization program as so established. The use of the reserved amount to carry out that program may be accomplished either as a part of awards made to the universities and colleges involved for activities carried out under the authority of other laws or through separate awards made for purposes of this Act; and in either case such amount shall be so used only on the basis of proposals submitted by such universities and colleges as described in section 3(c).

(2) The minimum amount to be reserved for purposes of this Act and used as described in paragraph (1) in any fiscal year, out of the total sum appropriated to the Foundation for that year and available for obligation by the Foundation for research or research and development awards to universities and colleges, shall be the lesser of—

(A) 10 percent of such total sum; and

(B) the amount by which—

(i) the full amount of such total sum, plus the amount that was reserved for purposes of this Act and used as described in paragraph (1) in the preceding fiscal year, exceeds

(ii) the full amount of the corresponding total sum (appropriated to the Foundation and available for obligation by the Foundation for research or research and development awards to universities and colleges) for the preceding fiscal year.

(3) At least 15 percent of the amount which is required to be reserved for purposes of this Act and used to carry out the Foundation's university research laboratory modernization program in any fiscal year under paragraph (1) shall be available only for awards to universities and colleges that received less than $10,000,000 in total Federal obligations for research and development (including obligations for the university research laboratory modernization program) in each of the two preceding fiscal years.

TITLE II—FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF HEALTH AND HUMAN SERVICES

FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF HEALTH AND HUMAN SERVICES

SEC. 201. (a) There is hereby authorized to be appropriated to the Department of Health and Human Services for the fiscal year 1987, for the specific purpose of implementing and carrying out the new university research laboratory modernization program established by the Department pursuant to section 3(b) of this Act, the sum of $200,000,000.

(b)(1) Of the total sum appropriated to the Department of Health and Human Services for each of the fiscal years 1988 through 1996 and available for obligation by the Department for research or research and development awards to universities and colleges, an amount at least equal to the minimum amount determined under paragraph (2) shall be reserved for purposes of this Act and used only to carry out the Department's university research laboratory modernization program as so established. The use of the reserved amount to carry out that program may be accomplished either as a part of awards made to the universities and colleges involved for activities carried out under the authority of other laws or through separate awards made for purposes of this Act; and in either case such amount shall be so used only on the basis of proposals submitted by such universities and colleges as described in section 3(c).

(2) The minimum amount to be reserved for purposes of this Act and used as described in paragraph (1) in any fiscal year, out of the total sum appropriated to the Department for that year and available for obligation by the Department for research or research and development awards to universities and colleges, shall be the lesser of—

(A) 10 percent of such total sum; and

(B) the amount by which—

(i) the full amount of such total sum, plus the amount that was reserved for purposes of this Act and used as described in paragraph (1) in the preceding fiscal year, exceeds

(ii) the full amount of the corresponding total sum (appropriated to the Department and available for obligation by the Department for research or research and development awards to universities and colleges) for the preceding fiscal year.

(3) At least 15 percent of the amount which is required to be reserved for purposes of this Act and used to carry out the Department's university research laboratory modernization program in any fiscal year under paragraph (1) shall be available only for awards to universities and colleges that received less than $5,000,000 in total Federal obligations for research and development (including obligations for the university research laboratory modernization program) in each of the two preceding fiscal years.

TITLE III—FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF DEFENSE

FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF DEFENSE

SEC. 301. (a) There is hereby authorized to be appropriated to the Department of Defense for the fiscal year 1987, for the specific purpose of implementing and carrying out the new university research laboratory modernization program established by the Department pursuant to section 3(b) of this Act, the sum of $100,000,000.

(b)(1) Of the total sum appropriated to the Department of Defense for each of the fiscal years 1988 through 1996 and available for obligation by the Department for research or research and development awards to universities and colleges, an amount at least equal to the minimum amount determined under paragraph (2) shall be reserved for purposes of this Act and used only to carry out the Department's university research laboratory modernization program as so established. The use of the reserved amount to carry out that program may be accomplished either as a part of awards made to the universities and colleges involved for activities carried out under the authority of other laws or through separate awards made for purposes of this Act; and in either case such amount shall be so used only on the basis of proposals submitted by such universities and colleges as described in section 3(c).

(2) The minimum amount to be reserved for purposes of this Act and used as described in paragraph (1) in any fiscal year, out of the total sum appropriated to the Department for that year and available for obligation by the Department for research or research and development awards to universities and colleges, shall be the lesser of—

(A) 10 percent of such total sum; and

(B) the amount by which—

(i) the full amount of such total sum, plus the amount that was reserved for purposes of this Act and used as described in paragraph (1) in the preceding fiscal year, exceeds

(ii) the full amount of the corresponding total sum (appropriated to the Department and available for obligation by the Department for research or research and development awards to universities and colleges) for the preceding fiscal year.

(3) At least 15 percent of the amount which is required to be reserved for purposes of this Act and used to carry out the Department's university research laboratory modernization program in any fiscal year under paragraph (1) shall be

available only for awards to universities and colleges that received less than $5,000,000 in total Federal obligations for research and development (including obligations for the university research laboratory modernization program) in each of the two preceding fiscal years.

TITLE IV—FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF ENERGY

FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF ENERGY

SEC. 401. (a) There is hereby authorized to be appropriated to the Department of Energy for the fiscal year 1987, for the specific purpose of implementing and carrying out the new university research laboratory modernization program established by the Department pursuant to section 3(b) of this Act, the sum of $25,000,000.

(b)(1) Of the total sum appropriated to the Department of Energy for each of the fiscal years 1988 through 1996 and available for obligation by the Department for research or research and development awards to universities and colleges, an amount at least equal to the minimum amount determined under paragraph (2) shall be reserved for purposes of this Act and used only to carry out the Department's university research laboratory modernization program as so established. The use of the reserved amount to carry out that program may be accomplished either as a part of awards made to the universities and colleges involved for activities carried out under the authority of other laws or through separate awards made for purposes of this Act; and in either case such amount shall be so used only on the basis of proposals submitted by such universities and colleges as described in section 3(c).

(2) The minimum amount to be reserved for purposes of this Act and used as described in paragraph (1) in any fiscal year, out of the total sum appropriated to the Department for that year and available for obligation by the Department for research or research and development awards to universities and colleges, shall be the lesser of—

(A) 10 percent of such total sum; and

(B) the amount by which—

(i) the full amount of such total sum, plus the amount that was reserved for purposes of this Act and used as described in paragraph (1) in the preceding fiscal year, exceeds

(ii) the full amount of the corresponding total sum (appropriated to the Department and available for obligation by the Department for research or research and development awards to universities and colleges) for the preceding fiscal year.

(3) At least 15 percent of the amount which is required to be reserved for purposes of this Act and used to carry out the Department's university research laboratory modernization program in any fiscal year under paragraph (1) shall be available only for awards to universities and colleges that received less than $2,000,000 in total Federal obligations for research and development (including obligations for the university research laboratory modernization program) in each of the two preceding fiscal years.

TITLE V—FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SEC. 501. (a) There is hereby authorized to be appropriated to the National Aeronautics and Space Administration for the fiscal year 1987, for the specific purpose of implementing and carrying out the new university research laboratory modernization program established by the Administration pursuant to section 3(b) of this Act, the sum of $20,000,000.

(b)(1) Of the total sum appropriated to the National Aeronautics and Space Administration for each of the fiscal years

1988 through 1996 and available for obligation by the Administration for research or research and development awards to universities and colleges, an amount at least equal to the minimum amount determined under paragraph (2) shall be reserved for purposes of this Act and used only to carry out the Administration's university research laboratory modernization program as so established. The use of the reserved amount to carry out that program may be accomplished either as a part of awards made to the universities and colleges involved for activities carried out under the authority of other laws or through separate awards made for purposes of this Act; and in either case such amount shall be so used only on the basis of proposals submitted by such universities and colleges as described in section 3(c).

(2) The minimum amount to be reserved for purposes of this Act and used as described in paragraph (1) in any fiscal year, out of the total sum appropriated to the Administration for that year and available for obligation by the Administration for research or research and development awards to universities and colleges, shall be the lesser of—

(A) 10 percent of such total sum; and

(B) the amount by which—

(i) the full amount of such total sum, plus the amount that was reserved for purposes of this Act and used as described in paragraph (1) in the preceding fiscal year, exceeds

(ii) the full amount of the corresponding total sum (appropriated to the Administration and available for obligation by the Administration for research or research and development awards to universities and colleges) for the preceding fiscal year.

(3) At least 15 percent of the amount which is required to be reserved for purposes of this Act and used to carry out the Administration's university research laboratory modernization program in any fiscal year under paragraph (1) shall be available only for awards to universities and colleges that received less than $2,000,000 in total Federal obligations for research and development (including obligations for the university research laboratory modernization program) in each of the two preceding fiscal years.

TITLE VI—FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF AGRICULTURE

FUNDING FOR THE UNIVERSITY RESEARCH LABORATORY MODERNIZATION PROGRAM IN THE DEPARTMENT OF AGRICULTURE

SEC. 601. (a) There is hereby authorized to be appropriated to the Department of Agriculture for the fiscal year 1987, for the specific purpose of implementing and carrying out the new university research laboratory modernization program established by the Department pursuant to section 3(b) of this Act, the sum of $25,000,000.

(b)(1) Of the total sum appropriated to the Department of Agriculture for each of the fiscal years 1988 through 1996 and available for obligation by the Department for research or research and development awards to universities and colleges, an amount at least equal to the minimum amount determined under paragraph (2) shall be reserved for purposes of this Act and used only to carry out the Department's university research laboratory modernization program as so established. The use of the reserved amount to carry out that program may be accomplished either as a part of awards made to the universities and colleges involved for activities carried out under the authority of other laws or through separate awards made for purposes of this Act; and in either case such amount shall be so used only on the basis of proposals submitted by such universities and colleges as described in section 3(c).

(2) The minimum amount to be reserved for purposes of this Act and used as described in paragraph (1) in any fiscal year, out of the total sum appropriated to the Department for that year and available for obligation by the Department for research or research and development awards to universities and colleges, shall be the lesser of—

(A) 10 percent of such total sum; and

(B) the amount by which—

(i) the full amount of such total sum, plus the amount that was reserved for purposes of this Act and used as described in paragraph (1) in the preceding fiscal year, exceeds

(ii) the full amount of the corresponding total sum (appropriated to the Department and available for obligation by the Department for research or research and development awards to universities and colleges) for the preceding fiscal year.

(3) At least 15 percent of the amount which is required to be reserved for purposes of this Act and used to carry out the Department's university research laboratory modernization program in any fiscal year under paragraph (1) shall be

available only for awards to universities and colleges that received less than $2,000,000 in total Federal obligations for research and development (including obligations for the university research laboratory modernization program) in each of the two preceding fiscal years.

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FACT SHEET

H.R. 2823
UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

Introduced by Rep. Don Fuqua (D-FL)
Chairman of the Committee on Science and Technology
U.S. House of Representatives
on June 20, 1985

- This legislation would reestablish an important federal investment in the physical infrastructure for research, which is so vital to our national science and engineering base. Several federal R&D agencies established programs for the construction of academic research facilities after the Soviet launch of Sputnik in 1958. Such programs, although they were uncoordinated, helped build U.S. research capacity in the 1960's, but by the early 1970's the programs were terminated.

- H.R. 2823 would authorize the creation of university and college research laboratory modernization programs in the six leading federal R&D agencies: the National Science Foundation (NSF), the Department of Health and Human Services (HHS), the Department of Defense (DOD), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the Department of Agriculture (USDA).

- The legislation would authorize start-up funds for the laboratory modernization programs, and would require structural changes in the R&D agency budgets that provide for a steady, systematic investment in university research facility renewal that is now absent from the budget process. This investment would be indexed to the annual level of federally-supported R&D performed at our universities and colleges.

- The federal share of the ten-year program would be roughly $5 billion, which would leverage another $5 billion in non-federal funds, for a total of $10 billion.

- The National Science Foundation would play a special coordinating role. Beginning in fiscal year 1986, NSF would be authorized to carry out periodic assessments of university and college research facility needs, and to report on the implementation of the laboratory modernization programs.

- For the first year of the ten-year facility modernization program, fiscal year 1987, H.R. 2823 would authorize "start-up" funds for six agency programs. The amount of each agency authorization would be roughly proportional to that agency's current obligations for R&D to universities and colleges.

- The total FY 1987 authorization is $470 million, which is somewhat less than 10 percent of the total of all federal obligations for R&D to higher education institutions. (In FY 1983 the latter total was $5 billion.)

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- The FY 1987 authorization is divided among the six leading federal R&D agencies as follows:
  NSF: $100 million
  HHS: $200 million
  DOD: $100 million
  DOE: $25 million
  NASA: $20 million
  USDA: $25 million

- For the second through the tenth year of the program, FY 1988 - FY 1996, each of the six agencies would be required to reserve at least 10 percent of their R&D obligations to universities and colleges for their facility modernization programs, which at that point would form part of the R&D base of each agency.

- H.R. 2823 contains a critical provision to protect the base of university R&D funding, so that the 10 percent formula for laboratory modernization not be an undue tax on funding for research grants. This provision prevents the facility programs, once established, from growing dollarwise any faster than the R&D base during years of increased R&D funding. The bill also takes into account the unpleasant possibility of decreased R&D funding. During such years the modernization program formula would be reduced below 10 percent, and would, in fact, become zero in the event R&D funding was cut 10 percent or more.

- The bill also contains a key provision which assures that the facility programs do not favor the big, well-established, research universities over the smaller or newly-emerging, higher education institutions. This provision requires that at least 15 percent of the amounts that are reserved (10 percent of academic R&D obligations) for the facility programs would be available to those universities and colleges below the first 100 institutions in overall federal R&D funding. Indeed, these institutions, taken together, receive 15 percent of federal R&D funding to all universities and colleges, and this provision assures that they receive at least a proportional share of facility funding.

- H.R. 2823 calls for a six agency program, and is within the jurisdiction of four Committees in the House of Representatives: the Committees on Agriculture, Armed Services, Energy and Commerce, and Science and Technology. Chairman Fuqua has today written to the Chairmen of the other three Committees requesting their co-sponsorship of the bill and urging their leadership in further refining provisions.

- Chairman Fuqua intends this legislation to be a vehicle to develop consensus within the Congress, within the Executive Branch, and within the academic community that it so directly affects. He plans to have the Committee on Science and Technology convene a comprehensive set of hearings on the bill to receive the views of all concerned.

Mr. WALGREN. Well, thank you very much for that statement and for the focus that your bill provides on this question. And I certainly want to say, from my own anecdotal experience, the need is very severe, and I hope that we can generate a near term response in the Congress.

Historically, can you shed any light on the cycles that you referred to in your testimony in 1960 and thereabouts, when we pumped some money into this area? And that is apparently less than we're doing today. Do we have comparisons that we can make with past years in terms of the investment of the Federal Government into research facilities?

Mr. FUQUA. Well, I think the peak year was around 1966 in the amount of money, and I think that was around $160 million in 1966 dollars. If you compute that to 1986 dollars, that would be about $480 million. The bill authorizes about $470 million in start up funds. So, if you get a comparison—and of course today, the R&D for Federal investment in R&D plant at the universities and colleges, today—well, in 1984, the last figures that I have available, was about $40 million. So——

Mr. WALGREN. $40 million?

Mr. FUQUA. $40 million. So, we are down considerably from where we were, and that's in 1984 dollars. Compute that to whatever base you want to use compared to 1966, you could readily guess that that's probably $10 or $15 million.

Mr. WALGREN. Yes.

Mr. FUQUA. A very small amount.

Mr. WALGREN. And would that include the indirect attempts to inject some resources to these—apparently attached to research grants there would be some consideration given for equipment, or so the NSF has tried to do, I guess, particularly in these last——

Mr. FUQUA. I don't think they've had any for facilities in recent years, or a very small amount, which I mentioned was around $40 million. But I don't think there's really been—that included, I think, all the indirect and direct.

Mr. WALGREN. And would you——

Mr. FUQUA. That would not include the overhead costs, the indirect costs that are factored into some of the grants. But most of that money has been utilized for operating money. So, I think very little of that has gone back into the plant and equipment.

Mr. WALGREN. How, in your proposal, do you anticipate dealing with the smaller and newer institutions that aren't in the flow of present research dollars in a major research university way? Because clearly a lot of members of Congress are very sensitive to the distributive factors which may or may not be helping their own areas and their own universities, and worry about the inherent concentration when you focus—as I understand you do—on competitive grants.

Mr. FUQUA. Well, of course, it will be competitive, but as I stated in my opening statement, it was not intended to just help a few of the more select, prestigous colleges and universities in the country. And to further augment that, we have a set-aside of at least 15 percent for institutions that are typically below the top 100 in Federal R&D funding. So, we are targeting some of these institutions that would be below that list.

But we also have two categories that would compete for the awards. First these institutions could compete with all of them for the first 85 percent, and then could participate in the set-aside of the 15 percent. Nothing would prevent them from competing in both categories if they were below the top 100 in Federal R&D funding.

Mr. **Walgren**. So, they would be competing in their own arena for a certain amount of the resources, and then they could also compete in the—or the proposals could also be submitted for both.

Mr. **Fuqua**. In the set-aside, right.

Mr. **Walgren**. And it could also be viewed as simply a limitation on the large schools, couldn't it? Although 85 percent is a substantial limitation, it is—well, not a substantial limitation. I mean it's a substantial part of the resources. But you could also view that as a limit on the present large schools for how much of this program they are going to have unlimited participation in.

The small schools could participate more than 15 percent, couldn't they?

Mr. **Fuqua**. That's correct. Nothing prohibits one of the small schools. It may be 250th in rank in Federal R&D for competing against one of the larger schools and maybe win, because you know, when you get to the question of suppose you're building a chemistry building, or refurbishing one, it seems to me it would get very difficult to determine just what kind of science you would have. If you're competing strictly on science, I think you'd have to include other factors. What is the regional impact? How much has this school ever received in the past? What is its potential? Have they developed a very strong department, of whatever it might be—I was using chemistry as an example. I think other factors could work in.

However, we don't outline those in this bill. That would be left up to the various agencies to——

Mr. **Walgren**. So, when we say competitive here, we're not limiting the competition to some kind of purely scientific contest or contest judged——

Mr. **Fuqua**. Well, certainly it has to be on merit and value that would be generated from that. You can't just do it because you like somebody. But I think if you're building a facility, what is it to be used for? And in that context, what is the need for it compared to school B? What are the other factors I think would be appropriate—even though we do not outline those and I am not attempting to do that in my response to your question—but I think there are other factors that should be considered in the allocation of these funds.

Maybe the emergence of that institution, regional economic impact that it may provide to a certain area of the country, or a revitalization of a university that needs revitalization. Maybe it's going through some hard times in recent years, or a region of the country that that has happened to, and it's important for that.

I think all these factors are things that should be considered without trying to outline them in some rigid fashion.

Mr. **Walgren**. As you know, we've talked about the distributive problem and the problem some of the institutions have in competing for grants in such intense competition. And I've been struck by how the Congress, when it set out the charter of the National Science Foundation, talked about strengthening the potential for research. I think those are pretty close to the words that the Congress chose then.

And we have largely done that by doing research, and that's one way you can certainly strengthen the potential for research. But I think that if you really think about that word potential, it's a very developmental word. And I know that when you talk about building facilities, you really are looking forward to a future capacity and you are really sort of, or essentially creating a potential. That's really what you're doing.

And I would certainly hope that there are factors that would result in the broadest participation of meritorious science institutions in this kind of a program, and not some left out.

Mr. **Fuqua**. I'm positive that there is a difference between the scientific research that a researcher presents to the Federal agency to do a specific research. And that person, or that team, may have a long history of very successful research, and one of the truly outstanding researchers in the country. And certainly we would want to still do those on merit, of some type of review process.

But in the case of facilities it's a little different. Now, you may have an outstanding researcher that needs additional facilities to perform certain further advanced scientific research, or it may be a case of revitalizing the chemistry building that I was discussing, or some other type of facility.

It was also not intended to be—and I think with the 50-50 matching limitation, that we're not trying to go out and build huge facilities, that these would be more the normal type facilities that we would need, rather than the type of some big, costly building that then may not result in any research being conducted in them because they didn't win that scientific proposal.

I think we have to be very careful not to do that, and I think there are built in cautions against that by fact of the local money that must be raised to do that. But I think in facilities you have a little broader latitude to accomplish what you were discussing earlier, in trying to help emerging institutions; those that may have changing demographics in their region of the country, or what are the regional needs that need to be served.

The gentleman—to cite an example, I know that we have been working on the Steel Initiative that is very important to certain regions of this country. In that particular case that's a regional application. I would think that something to compliment that would certainly receive high support based on other factors of merit.

So, while there are certain projects to do research, or are strictly based on research, I think this can be also based on not only the quality of research that would be produced there, but also other extenuating factors that would contribute to the overall good of the project.

Mr. **Walgren**. The chair would recognize Mr. Lujan.

Mr. **Lujan**. Thank you, Mr. Chairman. And, Mr. Chairman, I think you're correct in your last statement that said I'm confident that the bill, as presently structured, comes very close to what the Nation needs. And I agree with you that that's exactly what we have to do, what you're attempting to do here.

I do have a couple of questions. One, you talk about $470 million. There's no question that that's a problem right now to add that much onto each one of these departments.

Would you see the likely scenario that if this is authorized and we don't come up with the additional appropriations, the $470 million, that the agencies take that from their present budget?

Mr. **Fuqua**. Well, I think it would not be taking it from the present budget. It would probably be a redirection from the present budget up to that amount, or up to 10 percent. And I think the authorization is probably more important today than the $470 million. The fact that we can start directing some of these funds into these facilities, then hopefully as budget matters ease—and I hope they will, I'm not sure they will in the immediate future—I think that we can—it doesn't take that much out of any one of the agencies. I don't think 10 percent—while they're still getting the research that they started out with—I don't think that's going to do irreparable damage to any of the agencies. It will probably improve the quality of research that they're getting today.

Mr. **Lujan**. And I agree with you. My only question was, you know, the opportunity of getting $470 million is kind of grim at this time.

Mr. **Fuqua**. I agree with the gentleman.

Mr. **Lujan**. The other thing that concerns me a little bit is the 15 percent. Although you say that a university can apply under the 85 percent and also under the 15 percent, if they're under the top 100, yet I don't feel very confident that a small university would get any funds under the 85 percent. To be very honest about it, I think there is a bias in NSF, for example, toward the large universities. And we've talked about that in the Science Policy Task Force.

Those charts show that by States—for example, California, New York, Massachusetts, Illinois, and Pennsylvania, those 5 States get 52 percent of all of the money from National Science Foundation. If you take the next 10 States it's 67 percent, and if you get to the top 20 it's 86 percent of the money that's taken.

Each one of us, of course, has a different idea, and I suppose you could write 535 different bills and come up with different percentages. But my thought was that this is a good way to build up those smaller universities. As you remember, a lot of the testimony in the Science Policy Task Force was that because these big universities have the facilities, that they get the big bucks for the research. That if the smaller universities had the smaller facilities—better facilities rather—that they would probably be able to qualify for some of the National Science Foundation grants.

I'm just wondering if it might—being that this is a facilities program, rather than a research grant program, should we tilt it heavier in favor of the smaller institutions?

Mr. **Fuqua**. Let me say to my friend, the 15 percent was debated; was that low enough, too high, need to be higher? I think during the course of these hearings that that's an excellent opportunity to pursue that very question. As I said, the bill as written—is not in sanctity and that is one of the areas that I have given considerable thought. Should it be increased? I certainly don't think it should be lowered.

And I think that during the course of the hearings that that would be an excellent thing to explore, to see what impact that figure might have or should it be increased. Again, I say, it's not cloaked in sanctity.

Mr. LUJAN. One other thing that is kind of bothersome to me is the 50–50 cost sharing. Now, I'm one that happens to believe that there should be some cost sharing in just almost everything that the Federal Government does. That guarantees that it's a worthwhile project and not just—I'm going to build a new engineering building because—oops, that's a wrong example—some other kind of a building just because you give it to me.

But the smaller institutions might have difficulty in coming up with the 50 percent. Certainly an MIT or a Princeton or somebody like that who are in the top would have no trouble coming up with the 50 percent, but some small university might, and that's one other thing that we might do. That rather than arbitrate 50–50, that there may be some other criteria like ability to pay, or something like that, that might tilt it in favor of the smaller——

Mr. FUQUA. Well, this is primarily aimed at our research universities, not necessarily a liberal arts college or someone of that type. But I think—you know, you take New Mexico State University, I would imagine that if they had a $5 million building, they could get a couple of million from the State if they were getting matching money from the Federal Government to do that.

They could even, depending on the States and their ability, have a bond issue to pay for part of their matching money.

Mr. LUJAN. I was thinking primarily maybe private colleges.

Mr. FUQUA. Well, that's true. However, private schools today have no matching funds. And this is—we're saying we will give half. Today they have nothing.

Mr. LUJAN. Unless they have a friendly Congressman that can sponsor a——

Mr. FUQUA. Well, even if the gentleman would check some of those that had friendly Congressmen, you'll find that they have raised more than half of the money for those facilities. What the Federal Government put in was very small.

Mr. LUJAN. One final question, again tilting toward the smaller schools. The bill calls for cost sharing with universities. Has the point been raised that that might be changed to qualify some four year colleges that might be pretty good at research, rather than limiting it to the universities, or was that the gentleman's intention?

Mr. FUQUA. Well, we were primarily aiming this at those that are traditionally involved in research. Usually those involved in research have graduate programs. And that's what we're really looking at—providing the needs for the country for researchers and scientists in the future. And so we do make a distinction about providing that it's intended for research oriented—not total research oriented, but those that have research programs in their curriculums. And it would be aimed at those because that's what we found, as the gentleman knows, in our science policy, in the manpower hearings we had last week.

The critical shortage of graduate engineers and mathematicians and other scientists to fulfill the needs not only in the country and industry, but also in the faculty positions in our colleges and universities.

Mr. **Lujan**. Absolutely.

Mr. **Fuqua**. So, while we recognize that maybe a liberal arts college may need a chemistry building, I don't think under the fiscal restraints that we're faced with today that we can solve all those problems in this bill. I think we have to look at where the critical needs are, has it been identified, and try to target at those at the present time.

Now, should things ease up and money becomes more readily available, I think we may find, you know, maybe some programs for that. But even if you go back to the program after 1958, I think you'll find that most of those funds for facilities in that program were targeted toward schools with graduate programs and consequently research programs.

Mr. **Lujan**. I was referring to universities that in the past—I don't know what they're called now, but it was tech, like—I don't know if there was a Florida Tech, there was a New Mexico Tech, different ones that were engineering colleges anyway. And I'm not sure if they do offer graduate degrees or not. That's kind of the type of college that I was thinking of.

I want to thank the gentleman. I think that what he's doing is exactly what we need in this country. And I might tell him that as you can tell by the direction of my questions, that it might be a vehicle to solve that problem that we run into of the larger universities; the rich get richer and the smaller ones are kind of left behind. And that's the only purpose of my questioning.

Thank you very much.

Mr. **Mineta** [acting chairman]. Mr. Andrews?

Mr. **Andrews**. Thank you, Mr. Mineta. Just to follow up on what Mr. Lujan was pointing to in his questions. There surely does seem to be a need to spread the research out around this country, and obviously there is a disproportionate amount of Federal dollars levied to just a few States that do most of the research.

I wonder if the chairman would mind commenting in general about how this piece of legislation addresses the needs of redistribution of some of those funds to revitalize basic research in other institutions other than just the few that have received so much of our Federal dollars.

Mr. **Fuqua**. Well, let me respond to the gentleman by saying that of course we're talking about two things here. One is the pure research that the traditional agencies of the Government support, whether it be in applied physics or whatever it might be. In this one we're talking about facilities. And as I was responding to Mr. Walgren earlier, that I think that in this bill it would give greater flexibility to have an opportunity to look not only at the scientific merits of the work that would be performed there, but also for regional impact and economic needs in certain areas of the country—changing demographics—that are unique problems that might be associated with one region of the country versus another.

I think we still have to look at quality science coming from our investment, but at the same time—and we do not set out guidelines, the agencies would still do that—but I would think in looking at facilities, it would lend itself to a more flexible review of critical needs that might be unique to a certain specific area of the country.

Mr. **Andrews**. Well, surely one of the reasons that some of the States have not fared as well with some of the research grants is simply because their research facilities are not capable of handling the load or doing the type of indepth quality work, research work, that is necessary. And certainly that's one of the things that this bill——

Mr. **Fuqua**. Well, facilities is only one part. Faculty and researchers are the other very important ingredients. I think this would help if someone had quality facilities to conduct research in, it would certainly help attract quality faculty. And then with that, I think you would see the other research dollars follow in that direction.

Mr. **Andrews**. Let me turn your attention to one of the specifics of the legislation. The first year of the 10 year Facility Modernization Program, 1987, as I understand it there are start up funds for six different agency programs. I wonder if you would elaborate a little bit on that for the committee.

Mr. **Fuqua**. Well, there's been a great deal of interest expressed by—and as you know, this has gone to several other committees in the House—there was a great deal of interest expressed by the Armed Services Committee in increasing the funding for research by the Department of Defense considerably in the budget that was passed this year.

In the House Agriculture Committee similar initiatives have been expressed. So, I think you will find that those are the two major players that have jurisdiction, along with this committee, that they have played a very prominent role in recognizing the need.

This legislation will go before those committees. But based on the indications of actions that they've already taken this year, that it would be very receptive to those committees and to the agencies that they have under their jurisdiction.

Mr. **Andrews**. With regard to the National Science Foundation, what role would they play in the bill?

Mr. **Fuqua**. Well, the Science Foundation initially would be assigned the responsibility to try to do an inventory or a survey or an assessment of the needs of facilities throughout the United States. That report would be made back to the Congress. That is the only special provision that they have that is different from other agencies.

The other agencies would then be the Department of Agriculture, the Department of Defense, HHS, which is primarily NIH, would have the flexibility to operate as they see fit. We don't try to set specific regulations for each of the agencies. I think it would be a mistake to do that. We charge them with the responsibility and say, you people are the ones that are paid to go and find out a way to implement this.

But we do charge the National Science Foundation with coming back with an assessment of how they view the facilities at the universities, and the associated cost which would probably be very staggering. Most of these buildings, or a lot of these buildings that have been built—are 25 years old. Some of them even date back prior to World War II.

So, I think once we have a better defined assessment of the need, I think it would be very dramatic in what our needs really are, and that this bill is just a drop in the bucket in trying to solve those needs.

Mr. ANDREWS. Thank you, Mr. Chairman.

Mr. MINETA. Mr. Chairman, do I understand that NSF also does the assessment after the——

Mr. FUQUA. They do the initial assessment for the needs and requirements.

Mr. MINETA. And the monitoring?

Mr. FUQUA. Yes.

Mr. MINETA. Mr. Cobey?

Mr. COBEY. I have no questions. I just want to thank the chairman for bringing this bill forward so that we can have hearings and discuss it.

Mr. MINETA. Mr. Chairman, let me ask, do you contemplate the inclusion of scientific instrumentation and equipment under this bill as well?

Mr. FUQUA. Well, the grants are intended to be for facilities, that is, the research laboratories, associated office space, et cetera. If there's a compelling reason for—and an agency is convinced, one of the departments, that equipment for a single program or something, then of course I wouldn't have any objection to combining that if adequate funds were made available for both facilities and equipment. But it's primarily aimed at facilities.

Mr. MINETA. The——

Mr. FUQUA. And let me say that there is a very critical need for equipment and instrumentation. We, again, felt that under the severe fiscal constraints that we're having to operate under that—if we had plenty of money I could write this bill a lot different than it is. But, as the gentleman knows, we're on a very, very strict and tight budget constraint. As great an optimist as I am, I don't see that easing in the next number of years. I wish it were, but I don't see it that way.

So what we're trying to do is really—as the phrase around here many, many times goes, this is a bare bones approach to try to address a very critical problem, hoping that that may free up some money in other areas for instrumentation and equipment. It is in no means to ignore or walk away from that problem that is very critical. But it appears that facilities are very severe right now, and that that is where the most critical need is. And then after that is resolved, then maybe it will free some money up for equipment. That is a very serious problem.

Mr. MINETA. I notice in your testimony——

Mr. FUQUA. But we just don't have the money in this, that I see, that we can address both of these problems, as they should be, together.

Mr. MINETA. I notice that in your testimony you talk about no new money, but with funds redirected from elsewhere in the Federal R&D budget. Does that take away from programmatic areas to accommodate the brick and mortar piece of it?

Mr. **Fuqua.** Well, that could be one of the criticisms of the bill, and depending on your point of view and where you come from. Come from, meaning if you're involved with a national lab or something of that type. It is hoped that once this money, or once this bill is authorized that that will not occur. It's not our intention to try to purposely take away existing money that's going into other worthy projects. That through some readjustment, sharpening the pencil, and other means of juggling, that this can in someway come about, and maybe with the authorization for some additional money, that it can help offset some of that.

This doesn't start until 1987, and we're hopeful that the science budgets have been increased some. Not as much as maybe they should, but they've been increased some over the years. I hope that this Congress continues to see the priority or recognizes the priority and the importance of what this research does, both in the national laboratories and also, as well, in our colleges and universities, which really train the faculty and researchers that the Government needs.

Mr. **Mineta.** Now, I notice that your bill also calls for 10 percent for academic research, or that 10 percent would be reserved for facilities in academic research. Why 10 percent?

Mr. **Fuqua.** Well, that's a kind of arbitrary figure, too. We felt like if we went much higher than that, that it may have some adverse impact on the agencies or them resist a higher figure. However, most industries program 15 percent as a set-aside for new research facilities. We used that figure and reduced it to 10 percent, here again, as a bare bones approach for solving a very serious problem.

Mr. **Mineta.** The——

Mr. **Fuqua.** It could be higher, it could be lower. We felt that based on what was our best judgment that this was probably the best figure that we could come up with.

Mr. **Mineta.** So there hasn't been an identification of the total needs in the—as far as the national picture is concerned.

Mr. **Fuqua.** I don't think there's been a total compilation. There's been several meetings to discuss this, and meetings anytime that I've been in with academic people, it's been one of the number one topics on their mind.

If you go and visit colleges and universities—and I have on numerous occasions—you very readily see the acute need that they have. There was a meeting, I mentioned in my testimony, last week down at the National Academy of Sciences about this very same thing. We had meetings in our task force on Science Policy, which the gentleman is a member, on this very thing.

So, while I don't think there's been an inventory of all of these, there's been, certainly individually and collectively, a lot of discussion about it, and about what it might cost, you know, from $15 to $40 billion that it may be. That's why we're asking the National Science Foundation to really better define what the needs and cost estimates are.

Mr. **Mineta.** Is there a limitation on how the money might be spent or for what purpose? Let me give you an example. Suppose one university gets money for a cyclotron when another university can't even get money for basic research facilities. Is there a limitation as to how that money gets——

Mr. **Fuqua**. We do not place a limitation that would prevent that scenario from happening. However, it is not the intent for this to be the vehicle for big funding projects. And I think there is a self-governing feature there, and that is the 50-percent local money that must be raised for it.

We do not set forth specific guidelines and say well, no, we exclude cyclotrons, but we will support chemistry labs or vice versa.

Mr. **Mineta**. But even in the——

Mr. **Fuqua**. But the agency has to make some of those calls.

Mr. **Mineta**. But even in the raising of those funds, it may be easier for MIT to do it than Florida A&M.

Mr. **Fuqua**. Well, there's no doubt that it would be. And we would hope that the agency would take into consideration that we're not doing this to fund the big projects that not only cost a lot initially, but also you have to make sure you've got some funding to keep it going once you get a facility for it. If you get a cyclotron, who's going to pay for it to keep it operating?

So, we hope that it's not used for that, that it's used for more basic research facilities, even though a cyclotron would be for basic research. And I'm not opposed to cyclotrons, but I think that was not what we were attempting to do with this bill. We're talking about fixing up the chemistry labs, biology labs, or facilities for these so that quality research could be done there; not necessarily the big ticket items.

Mr. **Mineta**. Well, thank you very much, Mr. Chairman. I really appreciate your testimony. And, in fact, I know I haven't done it so far, but if you would go ahead and put me on the bill, I'd appreciate it.

Mr. **Fuqua**. Thank you, sir.

Mr. **Valentine**. Mr. Chairman.

Mr. **Mineta**. Mr. Valentine.

Mr. **Valentine**. Mr. Chairman, you might have already answered this question. I have been at a very placid Democratic meeting elsewhere in this building, and it got so interesting that I almost forgot my responsibility to be here at this subcommittee meeting—and you might have answered this question.

But I would like to know in a word or two, if possible, who would have the final say so—the final word as to where this money is expended? What universities get a share of these funds? Would it be the National Science Foundation or what?

Mr. **Fuqua**. Well, Mr. Valentine, the—and that's a very good question, and it hasn't been asked—we have the six agencies; NSF, DOD, DOE, and I'll probably miss some of them, NASA and HHS—and if that's not six then—but anyhow, each of those agencies—NSF would not tell the Department of Energy what to do or what not to do and vice versa. NSF would monitor and make periodic reports to Congress, but the Department of Agriculture would handle their own funds and you'd make an application to them, or the Department of Defense or NASA or NIH, which is under HHS. They would still be done individually. We would not try to cross-pollinate those agencies. They would still have their autonomy.

We do ask the National Science Foundation to do an initial survey, report back to us what they see the needs are, and then to keep up with somebody to coordinate, without authority to dominate, where the money is being spent and how is it being——

Mr. **Valentine**. How much new money, new Federal money, would be involved, and is there any kind of matching arrangement with respect to the individual universities or local Government?

Mr. **Fuqua**. There's $470 million of start up money, and the rest will come from 10-percent diversion within those agencies of their research funding. If their research funding goes up, then their money goes up. If it comes down, then it comes down.

The local college or university—if it was the University of North Carolina—they would be required to come up with 10 percent—I mean, with 50 percent of the money, or the State. Or if it were a private foundation, if it were a private school or even a State supported school, most of them have foundations and they can raise the money either privately, through gifts, or through the State or from bond issues that the State may issue for them. But they must come up with 50 percent of the money.

Mr. **Valentine**. Thank you, sir.

Mr. **Mineta**. I take it this is really to—since there's so much discussion about attainment of excellence—that this is really not for additional new construction for an expansionist policy of a university, but to retain and to revitalize whatever is existing right now in order that it be a good facility for academic pursuit rather than for new policies, or new building of new facilities——

Mr. **Fuqua**. We are not restricting that. If a building can be modernized then it would probably be more economical to do that. But there may be buildings that are totally inadequate; maybe they don't have the wiring and the plumbing to adequately serve the needs, and it would be more expensive to try to modernize the building than it would be to build a new one.

That's left up between the agency and the institution involved. We're not saying you can't remodernize. It may be worth keeping, it may have historical value. But there could also be a totally new facility built. There again, that is where the economics play in the issue.

Mr. **Mineta**. Thank you, Mr. Chairman.

Mr. **Walgren**. Mr. Chairman, the bill says 10 percent, is that right? That we would be reserving 10 percent of the amount? And yet, there are two sums described in the bill. The first sum I understand because it's 10 percent. The second sum, no matter how many times I read it, I can't understand how it is being determined. And you're to choose between the——

Mr. **Fuqua**. It's kind of a complex formula.

Mr. **Walgren**. Is there anyway that that—well, is that second number also 10 percent?

Mr. **Fuqua**. Well, it's kind of a complicated formula. I was just talking to the next witness, before the hearing, and I think she's worked it out. But it's one of those complex formulas that we come up against around here sometimes. And that will increase it as their budget increases, and likewise decrease it should their budget decline.

Mr. **Walgren**. Oh, I see.

Mr. **Fuqua**. Of the various agencies.

Mr. **Walgren**. Does it change the percentage or does it change the dollar amount? I guess that's the point that's——

Mr. **Fuqua**. It changes the dollar amount.

Mr. **Walgren**. And so that language is in there to allow that to float as the effort changes.

Mr. **Fuqua**. Right.

Mr. **Walgren**. Well, we certainly appreciate your involvement in this and what you've done with it so far. And we all recognize that what you focus on has a great deal of weight in the Congress as a whole, particularly in the areas of science and technology. And so, we anticipate a real life to this issue with your involvement in it.

And there's always the standing invitation to join this subcommittee whenever you'd like. We hope you could stay with us for a while and join in the hearing and discussions with the two follow-on witnesses. And we appreciate your having presented it thus far.

Mr. **Fuqua**. Well, thank you, Mr. Walgren. And let me also thank you and the subcommittee for the hearings and beginning them, because I think we are dealing with a matter that is of the utmost importance timewise, but also one that has great critical need. And I thank you for being here.

Mr. **Walgren**. Thank you. Well, come join us if you can.

Mr. **Fuqua**. I will.

Mr. **Walgren**. The next witness is Dr. Bernadine Healy, the Deputy Director of the Office of Science and Technology Policy. We appreciate your coming to the committee, Dr. Healy. Your written statement will be made part of the record, without objection, and please feel free to summarize or focus on those parts of it that you feel should be underscored in the process, if you would like to. So, welcome to the committee, and you're free to discuss this area with us in whatever way you feel most comfortable.

STATEMENT OF DR. BERNADINE HEALY, DEPUTY DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. **Healy**. Thank you, Mr. Walgren. Mr. Walgren, members of the subcommittee, once again I am pleased to join the subcommittee's deliberations on one of the most pressing issues facing the well-being of our research and education enterprise, and one which may have an impact on the future economic vitality and security of our Nation, and specifically, the condition of the physical infrastructure at our universities and colleges. I am particularly pleased that today's discussion will examine possible strategies and mechanisms needed to attack this urgent problem.

In my earlier testimony, on this subject, I stressed that the research facilities question is one, albeit a key, aspect of a much wider problem we must address—whether or not our Nation is in a position to ensure that our universities and colleges will be able to attract our most gifted, educate and train our new talent, and ultimately generate the fundamental knowledge we will need to remain preeminent in an age of rapid technological advancement and intense international economic competition. I further emphasized that in order to achieve this long-term strategic goal, our immediate objective must be to restore and revitalize the three-way partnership between government—both Federal and local—the universities, and industry, that over the years has created our research and educational system—a unique national asset unparalleled in the world today. To maintain America's undisputed preeminence in world leadership in science and technology, we must ensure that this critical interrelationship functions in concert, and that each partner fully understands and accepts its complementary role and special responsibilities.

In view of my own involvement in this debate, and the ongoing work of the White House Science Council's Panel, I am pleased to participate in today's discussion on "the University Research Facilities Revitalization Act of 1985," as introduced by Chairman Fuqua. Given the importance of this legislation as a tangible effort of the Federal Government to systematically invest in research facilities modernization, I would like to focus my remarks on the policy implications of the legislation, and then explore other approaches to this problem.

Before I turn to the specific provisions of the "Fuqua bill," as it is now commonly referred to, allow me to first underscore what I consider to be four essential criteria that must be embodied in any viable effort to redress the physical infrastructure problem. The four are: True cost, investment, diversity, and partnership.

The first principle concerns the controversial concept of "the true costs of research." There is no universally applicable rule of thumb for determining what are reasonable and necessary costs of the infrastructure components of research. Institutions have different expenses and needs according to their age, geographic location, and disciplinary areas of expertise. Today's concerns over the costs of facilities and equipment appears to stem from a general reluctance to recognize these costs as an integral, essential part of research. However, as the heightened attention to the infrastructure question has demonstrated, we seem to be arriving at a consensus that research facilities and equipment are a necessary, if not sufficient, part of research and education. Modern scientific investigation is impossible without modern laboratories, libraries, instruments, and computers, and the potential of each institution is fundamentally dependent upon the condition of its physical infrastructure. Accordingly, facilities and equipment expenditures and modernization must be treated as an inherent component of necessary research cost, and must not be treated as a distinct entity that detracts from "the real research base."

The second and essential principle is that our expenditures for research in universities are an investment in our future, and not a purchase of an immediate product. Therefore, any infrastructure plan should be approached as a long-term investment. The design of any initiative to address the current inadequacies should incorporate stability, continuity, and a commitment to avoid the "quick fix." A one-time emergency approach will not serve the interests of the Nation, but rather will continue to weaken the research and education system that fuels our future economic prosperity and maintains our national security.

A third principle is that any solution must aim to preserve the diversity and overriding excellence of the Nation's research and education establishment. We must resist any entitlement approach that would bypass merit-based evaluation. Clearly one of the strengths of U.S. research is the diversity that a merit-based system has fostered, allowing the growth of many different centers of excellence, institutions with unique capabilities and a degree of accessibility unmatched in the world. Such a system has allowed excellence to be maintained and has allowed new excellence to develop. We should not devise central solutions that might inadvertently homogenize our university system by failing to recognize the special characteristics of our public, private, and emerging institutions all over this country, or restrict an institution's opportunity to compete and achieve excellence.

The final principle I wish to emphasize is that any mechanism to solve the infrastructure problem at our universities and colleges must be designed to evoke and strengthen the partnership between Government, Federal and local, universities, and the private sector, that has worked so successfully in the past to produce this unrivalled national resource; namely, our university-based science and technology enterprise.

In relying upon this partnership to tackle facilities modernization, each partner must acknowledge their responsibility and accept a responsibility for success or failure.[1]

Mr. Chairman, I've devoted considerable attention to defining four broad principles that I believe must be reflected in any mechanism designed to attack the infrastructure problem with a reasonable chance of success. The Fuqua bill does indeed incorporate these criteria and goes further.

In effect, this legislation states that the Federal Government must assume the lead responsibility to initiate and oversee the Nation's reinvestment in research facilities modernization. By authorizing university and college facility programs in the six leading research and development Federal agencies, and requiring structural changes in these agency budgets to finance the necessary outlays over the next years, the Fuqua bill gives the Government the responsibility for setting the Nation's priority, Federal facilities modernization, and for reallocating the required Federal resources to accomplish the task at hand. We believe the Government has a responsibility, but that that responsibility is a shared one.

In my earlier testimony, on the infrastructure issue, I noted that since 1981 there has been a 30 percent real growth in Federal support for basic research, and since 1980, 23 percent real growth in university based research. However, since the early 1970's, both the Federal Government and the universities themselves have not adequately addressed the shared responsibility to invest in facilities and instrumentation. And the relative contribution of industry, of State and local governments, and private philanthropy has not managed to fulfill the need for modern state-of-the-art equipment and adequate facilities for research at our universities.

As I emphasized earlier, physical infrastructure must be recognized by all partners as a true and mandatory cost of research. If

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[1] Sentences deleted from written testimony: In adopting this strategy, we will witness a positive change in attitude and performance by each of the three partners. This will greatly enhance the health and unity of the entire system and heal many of the divisive counterproductive tensions that sometimes arise when the interdependence of a partnership is not acknowledged.

we accept this principle, and I believe now most do, then we should recognize that an imbalance in the distribution of the Nation's R&D resources has occurred since the early 1970's. This becomes clear when we view the research pool in its three components; direct cost of projects, administrative costs, and infrastructure. The direct costs of research have steadily grown with a notable increase in the 1980's. The universities pool of administrative costs has dramatically increased, much to the consternation of many, both within and outside the Government. However, the apparent loser has been facilities and instrumentation modernization. This segment of the research investment has fallen way behind in part because of the natural tendency to support human resources and let bricks and mortar wait.

The instrument gap has begun to be addressed in the last several years by the Federal Government. For example, the DOD Research Instrumentation Program, and the recent more than doubling by NSF of its investment in instrumentation and specialized research facilities. But they are just a start in tackling a long-term problem.

An appealing central thrust of the Fuqua bill is that it addresses the maldistribution of Federal research and development resources within the context of the entire research budget. Moreover, a key component, recognizing a shared responsibility, is the legislation's provision requiring a matching contribution for each Federal grant awarded. And that matching contribution can come from any sector; industry, private philanthropy, endowment, local government, bonds.

A repeated concern I have heard to H.R. 2823, from both the university constituency and from our funding agencies, is that the projected 10-year expenditure of $5 billion, indexed to the agencies annual research and development budgets, could significantly erode funds available to support the research base.

In addition, while the stipulation for matching funds would help restore and revitalize the partnership, this cost sharing requirement could possibly divert available resources away from the research base, and impose potential limits on a university's ability to obtain access to the Federal funds earmarked for facilities modernization.

This concern about the erosion of the research base is voiced in a time of tremendous budgetary constraints, and the realization that the overall Federal research and development pool may not be expanding is realistic. I do not personally applaud the prospect of no or little new money to fuel and augment the Nation's science and technology enterprise; a critical priority for the future of the Nation. Indeed, it is my personal view that a strong and persuasive case can and should be made for additional funds to support basic research at our universities, colleges, and research institutions.

Nevertheless, confronted with reality, we must set priorities. The choice is relatively simple. Shall the Nation use the resources we now have to address and solve the facilities problem, or shall we allow the imbalance in distribution of research dollars to persist with the risk to our long term research capability? Chairman Fuqua's proposed legislation is appealing in that it addresses the infrastructure problem independent of the extent of growth of the total research investment after the initial investment.

The administration, however, has serious reservations about a formula approach which restricts the flexibility of executive agencies to make priority choices in support of R&D, and believes that these agencies should not be constrained anymore than necessary by fixed and binding formulas. The administration believes that the Federal Government, through its research and development supporting agencies, should work with the universities, industry, and with the States to devise creative, flexible, and long term mechanisms to address the need for facilities for research.

Another concern about the bill, in its present draft, is that it appears to limit facilities modernization programs to universities and colleges. This would seem to exclude a significant segment of the not for profit institutions that conduct research; namely the free standing research institutes, consortia and centers. At NIH, for example, 19 percent of extramural research funds went to nonprofit research institutions other than universities or colleges in fiscal year 1984.

Mr. Chairman, before I conclude my remarks, I would like to share a complementary view on research facilities renewal. We all recognize the complexity and magnitude of the infrastructure problem. The ultimate key to its solution is most likely going to be that there is no one solution. What we need to encourage is the development of a package of mechanisms which will respond in fairness to the diversity of our research and education establishment, and will uphold the dual hallmarks of our unique system, heterogenity and excellence, and also preserve the needed flexibility within our R&D agencies.

I think it is clear from my earlier remarks that we support many of the principles inherent in the Fuqua Bill. Another strategy that also embodies these four principles of true cost, investment, diversity, and partnership, is one which the White House Science Council's Panel has discussed at length. That is, to deal with some of the imbalance through indirect cost recovery. The panel believes that indirect cost schemes should include realistic use allowances commensurate with the practices that operate in industry today. Use allowances, those portions of the Federal research grant reimbursements which reflect use and depreciation of university research facilities and capital equipment, should be based on actual useful life. The current lifetimes of 50 years for buildings and 16 years for equipment is unrealistic. It is essential that universities have a flow of resources adequate to allow them to pursue necessary modernization of their facilities on a continuing basis. The panel believes that changing the current approach to use allowance would help provide the flow of capital needed for this critical priority. Also there should be a means to ensure that recovered capital is used for this express purpose. For example, universities could be required to maintain separate escrow accounts for use allowance reimbursements, and these dollars not be welded into the universities annual operating budget.

This strategy is an investment approach which calls upon a partnership of shared responsibilities between Government and the universities. It recognizes the real cost of research, requires universities to effectively manage their resources and make long-term capital investments in facilities, and is directly tied to the peer review system that protects and mandates future excellence. However, changes in the use allowance structure and amortization periods will also cost money and will increase the universities relative expenditures for indirect versus direct costs.

The panel has considered that this approach should be linked to a realistic and fair structure for administrative cost recovery. This component of the real costs of research has risen dramatically in recent years and remains the most subjective and contentious issue in the continual controversy over indirect cost reimbursement.

Most of the panel believes that adopting some form of fixed, limited rate for administrative cost recovery, combined with relief from many of the reporting requirements, is one such rational and fair approach. Instituting a fixed-rate policy on administrative costs would decrease indirect cost reimbursement growth that, at least in part, could offset some of the increase in the use allowance charges.

Once again, this linked strategy underscores that central reality we must face; namely, that the total resources at our disposal for research and development are limited. The time has come to redefine our priorities. If there is a priority placed on maintaining and modernizing the physical infrastructure of one of our Nation's most vital assets our research and education establishment, then we must restore the three way partnership that guarantees long term success, and look closely at choices which allow us to maximize the productivity of the Nation's R&D resources to both solve this problem and protect our future.

Mr. Chairman, I appreciate being given the opportunity to discuss the criteria that we believe should be considered in any effort to address the physical infrastructure problem of university research facilities. We believe that H.R. 2823 is an important bill, in that it affords the research community the opportunity to consider an alternative for addressing a problem of concern to us, and to address the appropriate roles of the Federal Government, the States, universities, and industry. While the administration does not favor H.R. 2823, in its present form, we nonetheless applaud your efforts in focusing attention on this important and timely matter.

Mr. Chairman, I would now be pleased to answer any questions you might have.

[The prepared statement of Dr. Healy follows:]

PROPOSED TESTIMONY OF DR. BERNADINE HEALY
DEPUTY DIRECTOR
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
EXECUTIVE OFFICE OF THE PRESIDENT

BEFORE THE HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

JULY 30, 1985

MR. CHAIRMAN, ONCE AGAIN, I AM PLEASED TO JOIN THE SUBCOMMITTEE'S DELIBERATIONS ON ONE OF THE MOST PRESSING ISSUES FACING THE WELL-BEING OF OUR RESEARCH AND EDUCATION ENTERPRISE AND ONE WHICH MAY HAVE AN IMPACT ON THE FUTURE ECONOMIC VITALITY AND SECURITY OF OUR NATION, SPECIFICALLY, THE CONDITION OF THE PHYSICAL INFRASTRUCTURE AT OUR UNIVERSITIES AND COLLEGES. I AM PARTICULARLY PLEASED THAT TODAY'S DISCUSSION WILL EXAMINE POSSIBLE STRATEGIES AND MECHANISMS NEEDED TO ATTACK AND SOLVE THIS URGENT PROBLEM.

IN MY EARLIER TESTIMONY ON THIS SUBJECT, I STRESSED THAT THE RESEARCH FACILITIES QUESTION IS ONE, ALBEIT A KEY, ASPECT OF A MUCH WIDER PROBLEM WE MUST ADDRESS--WHETHER OR NOT OUR NATION IS IN A POSITION TO ENSURE THAT OUR UNIVERSITIES AND COLLEGES WILL BE ABLE TO ATTRACT OUR MOST GIFTED, EDUCATE AND TRAIN OUR NEW TALENT, AND ULTIMATELY GENERATE THE FUNDAMENTAL KNOWLEDGE WE WILL NEED TO REMAIN PREEMINENT IN AN AGE OF RAPID TECHNOLOGICAL ADVANCEMENT AND INTENSE INTERNATIONAL ECONOMIC COMPETITION. I FURTHER EMPHASIZED THAT IN ORDER TO ACHIEVE THIS LONG-TERM STRATEGIC GOAL, OUR IMMEDIATE OBJECTIVE MUST BE TO RESTORE AND REVITALIZE THE THREE WAY PARTNERSHIP BETWEEN GOVERNMENT - BOTH FEDERAL AND LOCAL, THE UNIVERSITIES, AND

INDUSTRY, THAT OVER THE YEARS HAS CREATED OUR RESEARCH AND EDUCATIONAL SYSTEM, A UNIQUE NATIONAL ASSET UNPARALLED IN THE WORLD TODAY. TO MAINTAIN AMERICA'S UNDISPUTED PREEMINENCE AND WORLD LEADERSHIP IN SCIENCE AND TECHNOLOGY, WE MUST ENSURE THAT THIS CRITICAL INTERRELATIONSHIP FUNCTIONS IN CONCERT AND THAT EACH PARTNER FULLY UNDERSTANDS AND ACCEPTS ITS COMPLEMENTARY ROLE AND SPECIAL RESPONSIBILITIES.

IN VIEW OF MY OWN INVOLVEMENT IN THIS DEBATE AND THE ONGOING WORK OF THE WHITE HOUSE SCIENCE COUNCIL'S PANEL, I AM PLEASED TO PARTICIPATE IN TODAY'S DISCUSSIONS ON "THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985" AS INTRODUCED BY CHAIRMAN FUQUA. GIVEN THE IMPORTANCE OF THIS LEGISLATION AS A TANGIBLE EFFORT OF THE FEDERAL GOVERNMENT TO SYSTEMATICALLY INVEST IN RESEARCH FACILITIES MODERNIZATION, I WOULD LIKE TO FOCUS MY REMARKS ON THE POLICY IMPLICATIONS OF THE LEGISLATION, AND THEN EXPLORE OTHER APPROACHES TO THIS PROBLEM.

BEFORE I TURN TO THE SPECIFIC PROVISIONS OF THE "FUQUA BILL," AS IT IS NOW COMMONLY REFERRED TO, ALLOW ME TO FIRST UNDERSCORE WHAT I CONSIDER TO BE FOUR ESSENTIAL CRITERIA THAT MUST BE EMBODIED IN ANY VIABLE EFFORT TO REDRESS THE PHYSICAL INFRASTRUCTURE PROBLEM. THE FOUR ARE: TRUE-COST, INVESTMENT, DIVERSITY, AND PARTNERSHIP.

THE FIRST PRINCIPLE CONCERNS THE CONTROVERSIAL CONCEPT OF THE "TRUE COSTS OF RESEARCH." THERE IS NO UNIVERSALLY APPLICABLE RULE OF THUMB FOR DETERMINING WHAT ARE REASONABLE

AND NECESSARY COSTS OF THE INFRASTRUCTURE COMPONENTS OF RESEARCH. INSTITUTIONS HAVE DIFFERENT EXPENSES AND NEEDS ACCORDING TO THEIR AGE, GEOGRAPHIC LOCATION, AND DISCIPLINARY AREAS OF EXPERTISE. TODAY'S CONCERNS OVER THE COSTS OF FACILITIES AND EQUIPMENT APPEARS TO STEM FROM A GENERAL RELUCTANCE TO RECOGNIZE THESE COSTS AS AN INTEGRAL, ESSENTIAL PART OF RESEARCH. HOWEVER, AS THE HEIGHTENED ATTENTION TO THE INFRASTRUCTURE QUESTION HAS DEMONSTRATED, WE SEEM TO BE ARRIVING AT A CONSENSUS THAT RESEARCH FACILITIES AND EQUIPMENT ARE A NECESSARY IF NOT SUFFICIENT PART OF RESEARCH AND EDUCATION. MODERN SCIENTIFIC INVESTIGATION IS IMPOSSIBLE WITHOUT MODERN LABORATORIES, LIBRARIES, INSTRUMENTS, AND COMPUTERS, AND THE POTENTIAL OF EACH INSTITUTION IS FUNDAMENTALLY DEPENDENT UPON THE CONDITION OF ITS PHYSICAL INFRASTRUCTURE. ACCORDINGLY, FACILITIES AND EQUIPMENT EXPENDITURES AND MODERNIZATION MUST BE TREATED AS AN INHERENT COMPONENT OF NECESSARY RESEARCH COSTS AND MUST NOT BE TREATED AS A DISTINCT ENTITY THAT DETRACTS FROM THE "REAL RESEARCH BASE."

THE SECOND AND ESSENTIAL PRINCIPLE IS THAT OUR EXPENDITURES FOR RESEARCH IN UNIVERSITIES ARE AN INVESTMENT IN OUR FUTURE AND NOT A PURCHASE OF AN IMMEDIATE PRODUCT. THEREFORE, ANY INFRASTRUCTURE PLAN SHOULD BE APPROACHED AS A LONG-TERM INVESTMENT. THE DESIGN OF ANY INITIATIVE TO ADDRESS THE CURRENT INADEQUACIES SHOULD INCORPORATE STABILITY, CONTINUITY, AND A COMMITMENT TO AVOID THE "QUICK-FIX". A ONE-TIME EMERGENCY APPROACH WILL NOT SERVE THE INTERESTS OF THE NATION, BUT

RATHER WILL CONTINUE TO WEAKEN THE RESEARCH AND EDUCATION SYSTEM THAT FUELS OUR FUTURE ECONOMIC PROSPERITY AND MAINTAINS OUR NATIONAL SECURITY.

A THIRD PRINCIPLE IS THAT ANY SOLUTION MUST AIM TO PRESERVE THE DIVERSITY AND OVERRIDING EXCELLENCE OF THE NATION'S RESEARCH AND EDUCATION ESTABLISHMENT. WE MUST RESIST ANY ENTITLEMENT APPROACH THAT WOULD BY-PASS MERIT BASED EVALUATION. CLEARLY ONE OF THE STRENGTHS OF U.S. RESEARCH AND HIGHER EDUCATION IS THE DIVERSITY THAT A MERIT BASED SYSTEM HAS FOSTERED, ALLOWING THE GROWTH OF MANY DIFFERENT CENTERS OF EXCELLENCE, INSTITUTIONS WITH UNIQUE CAPABILITIES, AND A DEGREE OF ACCESSIBILITY UNMATCHED IN THE WORLD. SUCH A SYSTEM HAS ALLOWED EXCELLENCE TO BE MAINTAINED AND NEW EXCELLENCE TO DEVELOP. WE SHOULD NOT DEVISE CENTRAL SOLUTIONS THAT MIGHT INADVERTENTLY HOMOGENIZE OUR UNIVERSITY SYSTEM BY FAILING TO RECOGNIZE THE SPECIAL CHARACTERISTICS OF OUR PUBLIC, PRIVATE, AND EMERGING INSTITUTIONS ALL OVER THIS COUNTRY, OR RESTRICT AN INSTITUTION'S OPPORTUNITY TO COMPETE AND ACHIEVE EXCELLENCE.

THE FINAL PRINCIPLE I WISH TO EMPHASIZE IS THAT ANY MECHANISM TO SOLVE THE INFRASTRUCTURE PROBLEM AT OUR UNIVERSITIES AND COLLEGES MUST BE DESIGNED TO EVOKE AND STRENGTHEN THE PARTNERSHIP BETWEEN GOVERNMENT, FEDERAL AND LOCAL, THE UNIVERSITIES, AND THE PRIVATE SECTOR THAT HAS WORKED SO SUCCESSFULLY IN

THE PAST TO PRODUCE THIS UNRIVALLED NATIONAL RESOURCE, NAMELY OUR UNIVERSITY-BASED SCIENCE AND TECHNOLOGY ENTERPRISE.

IN RELYING UPON THIS PARTNERSHIP TO TACKLE FACILITIES MODERNIZATION, EACH PARTNER MUST ACKNOWLEDGE THEIR RESPONSIBILITY AND ACCEPT A RESPONSIBILITY FOR SUCCESS OR FAILURE. IN ADOPTING THIS STRATEGY, WE WILL WITNESS A POSITIVE CHANGE IN ATTITUDE AND PERFORMANCE BY EACH OF THE THREE PARTNERS. THIS WILL GREATLY ENHANCE THE HEALTH AND UNITY OF THE ENTIRE SYSTEM AND HEAL MANY OF THE DIVISIVE, COUNTERPRODUCTIVE TENSIONS THAT SOMETIMES ARISE WHEN THE INTERDEPENDENCE OF A PARTNERSHIP IS NOT ACKNOWLEDGED.

MR. CHAIRMAN, I HAVE DEVOTED CONSIDERABLE ATTENTION TO DEFINING FOUR BROAD PRINCIPLES THAT I BELIEVE MUST BE REFLECTED IN ANY MECHANISM DESIGNED TO ATTACK THE INFRASTRUCTURE PROBLEM WITH A REASONABLE CHANCE OF SUCCESS. THE FUQUA BILL DOES INDEED INCORPORATE THESE CRITERIA AND GOES FURTHER. IN EFFECT, THIS LEGISLATION STATES THAT THE FEDERAL GOVERNMENT MUST ASSUME THE LEAD RESPONSIBILITY TO INITIATE AND OVERSEE THE NATION'S REINVESTMENT IN RESEARCH FACILITIES MODERNIZATION. BY AUTHORIZING UNIVERSITY AND COLLEGE FACILITY PROGRAMS IN THE SIX LEADING RESEARCH AND DEVELOPMENT FEDERAL AGENCIES, AND REQUIRING STRUCTURAL CHANGES IN THESE AGENCIES BUDGETS TO FINANCE THE NECESSARY OUTLAYS OVER THE NEXT YEARS, THE FUQUA BILL GIVES THE GOVERNMENT THE RESPONSIBILITY FOR SETTING THE NATION'S PRIORITY - FEDERAL FACILITIES MODERNIZATION -

AND FOR RE-ALLOCATING THE REQUIRED FEDERAL RESOURCES TO ACCOMPLISH THE TASK AT HAND. WE BELIEVE THE GOVERNMENT HAS A RESPONSIBILITY, BUT THAT RESPONSIBILITY IS A SHARED ONE.

IN MY EARLIER TESTIMONY ON THE INFRASTRUCTURE ISSUE, I NOTED THAT SINCE 1981, THERE HAS BEEN A 30% REAL GROWTH IN FEDERAL SUPPORT FOR BASIC RESEARCH, AND SINCE 1980, 23% REAL GROWTH IN UNIVERSITY-BASED RESEARCH. HOWEVER, SINCE THE EARLY 1970'S, BOTH THE FEDERAL GOVERNMENT AND THE UNIVERSITIES THEMSELVES HAVE NOT ADEQUATELY ADRESSED THE SHARED RESPONSIBILITY TO INVEST IN FACILITIES AND INSTRUMENTATION. AND, THE RELATIVE CONTRIBUTION OF INDUSTRY, OF STATE AND LOCAL GOVERNMENTS, AND PRIVATE PHILANTHROPY HAS NOT MANAGED TO FULFILL THE NEED FOR MODERN STATE-OF-THE-ART EQUIPMENT AND ADEQUATE FACILITIES FOR RESEARCH AT UNIVERSITIES.

AS I EMPHASIZED EARLIER, PHYSICAL INFRASTRUCTURE MUST BE RECONGIZED BY ALL PARTNERS AS A TRUE AND MANDATORY COST OF RESEARCH. IF WE ACCEPT THIS PRINCIPLE, AND I BELIEVE NOW MOST DO, THEN WE SHOULD RECOGNIZE THAT AN IMBALANCE IN THE DISTRIBUTION OF THE NATION'S RESEARCH AND DEVELOPMENT RESOURCES HAS OCCURED SINCE THE EARLY 1970'S. THIS BECOMES CLEAR WHEN WE VIEW THE RESEARCH POOL IN ITS THREE COMPONENTS: DIRECT COSTS OF PROJECTS, ADMINISTRATIVE COSTS, AND INFRASTRUCTURE. THE DIRECT COSTS OF RESEARCH HAVE STEADILY GROWN WITH A NOTABLE INCREASE IN THE 1980'S; THE UNIVERSITIES' POOL OF ADMINISTRATIVE COSTS HAS DRAMATICALLY INCREASED, MUCH TO

THE CONSTERNATION OF MANY, BOTH WITHIN AND OUTSIDE THE GOVERNMENT. HOWEVER, THE APPARENT LOSER HAS BEEN FACILITIES AND INSTRUMENTATION MODERNIZATION. THIS SEGMENT OF THE RESEARCH INVESTMENT HAS FALLEN WAY BEHIND IN PART BECAUSE OF THE NATURAL TENDENCY TO SUPPORT HUMAN RESOURCES AND LET BRICKS AND MORTAR WAIT. THE "INSTRUMENT GAP" HAS BEGUN TO BE ADDRESSED IN THE LAST SEVERAL YEARS BY THE FEDERAL GOVERNMENT - FOR EXAMPLE THE DOD-RESEARCH INSTRUMENTATION PROGRAM, AND THE RECENT MORE THAN DOUBLING BY NSF OF ITS INVESTMENT IN INSTRUMENTATION AND SPECIALIZED RESEARCH FACILITIES. BUT THEY ARE JUST A START IN TACKLING A LONG TERM PROBLEM.

AN APPEALING CENTRAL THRUST OF THE FUQUA BILL IS THAT IT ADDRESSES THE MALDISTRIBUTION OF FEDERAL RESEARCH AND DEVELOPMENT RESOURCES WITHIN THE CONTEXT OF THE ENTIRE RESEARCH BUDGET. MOREOVER, A KEY COMPONENT, RECOGNIZING A SHARED RESPONSIBILITY, IS THE LEGISLATION'S PROVISION REQUIRING A MATCHING CONTRIBUTION FOR EACH FEDERAL GRANT AWARDED - AND THAT MATCHING CONTRIBUTION CAN COME FROM ANY SECTOR - INDUSTRY, PRIVATE PHILANTHROPY, ENDOWMENT OR LOCAL GOVERNMENT.

A REPEATED CONCERN I HAVE HEARD TO THE HR 2823, FROM BOTH THE UNIVERSITY CONSTITUENCY AND OUR FUNDING AGENCIES, IS THAT THE PROJECTED TEN YEAR EXPENDITURE OF $5 BILLION, INDEXED TO THE AGENCIES' ANNUAL RESEARCH AND DEVELOPMENT BUDGETS, COULD SIGNIFICANTLY ERODE FUNDS AVAILABLE TO SUPPORT THE "RESEARCH BASE," IN OTHER WORDS "DIRECT COSTS." IN ADDITION, WHILE THE STIPULATION FOR MATCHING FUNDS WOULD HELP RESTORE AND REVITALIZE THE THREE WAY PARTNERSHIP, THIS COST-SHARING REQUIREMENT COULD POSSIBLY DIVERT AVAILABLE RESOURCES AWAY FROM THE RESEARCH BASE, AND IMPOSE POTENTIAL LIMITS ON A UNIVERISITY'S ABILITY TO OBTAIN ACCESS TO THE FEDERAL FUNDS EARMARKED FOR FACILITIES MODERNIZATION.

THIS CONCERN ABOUT THE "EROSION OF THE RESEARCH BASE" IS VOICED IN A TIME OF TREMENDOUS BUDGETARY CONSTRAINTS, AND THE REALIZATION THAT THE OVERALL FEDERAL RESEARCH AND DEVELOPMENT POOL MAY NOT BE EXPANDING IS REALISTIC. I DO NOT PERSONALLY APPLAUD THE PROSPECT OF NO OR LITTLE NEW MONEY TO FUEL AND AUGMENT THE NATION'S SIENCE AND TECHNOLOGY ENTERPRISE, A CRITICAL PRIORITY FOR THE FUTURE OF THE NATION. INDEED, IT IS MY PERSONAL VIEW THAT A STRONG AND PERSUASIVE CASE CAN AND SHOULD BE MADE FOR ADDITIONAL FUNDS TO SUPPORT BASIC RESEARCH AT OUR UNIVERSITIES AND COLLEGES. NEVERTHELESS, CONFRONTED WITH REALITY, WE MUST SET PRIORITIES. THE CHOICE IS RELATIVELY SIMPLE: SHALL THE NATION USE THE RESOURCES WE NOW HAVE TO ADDRESS AND SOLVE THE FACILITIES PROBLEM, OR SHALL WE ALLOW THE IMBALANCE IN DISTRIBUTION OF RESEARCH DOLLARS TO PERSIST WITH THE RISK TO OUR LONG TERM RESEARCH CAPABILITY. CHAIRMAN FUQUA'S PROPOSED LEGISLATION IS APPEALING IN THAT IT ADDRESSES THE INFRASTRUCTURE PROBLEM INDEPENDENT OF THE EXTENT OF GROWTH OF THE TOTAL RESEARCH INVESTMENT.

THE ADMINISTRTION, HOWEVER, HAS SERIOUS RESERVATIONS ABOUT A FORMULA APPROACH WHICH RESTRICTS THE FLEXIBILITY OF EXECUTIVE AGENCIES TO MAKE PRIORITY CHOICES IN SUPPORT OF R&D, AND BELIEVES THAT THESE AGENCIES SHOULD NOT BE CONSTRAINED ANY MORE THAN NECESSARY BY FIXED AND BINDING FORMULAS. THE ADMINISTRATION BELIEVES THAT THE FEDERAL GOVERNMENT THROUGH ITS RESEARCH AND DEVELOPMENT SUPPORTING AGENCIES SHOULD WORK WITH THE UNIVERSITIES, INDUSTRY, AND THE STATES TO DEVISE CREATIVE, FLEXIBLE, AND LONG-TERM MECHANISMS TO ADDRESS THE NEED FOR RESEARCH FACILITIES. ANOTHER CONCERN ABOUT THE BILL IN ITS PRESENT DRAFT IS THAT IT APPEARS TO LIMIT FACILITIES MODERNIZATION PROGRAMS TO UNIVERSITIES AND COLLEGES. THIS WOULD SEEM TO EXCLUDE A SIGNIFICANT SEGMENT OF THE NOT FOR PROFIT INSTITUTIONS THAT CONDUCT RESEARCH, NAMELY THE FREE STANDING RESEARCH INSTITUTES, CONSORTIA AND CENTERS. AT NIH FOR EXAMPLE, 19% OF EXTRAMURAL RESEARCH FUNDS WENT TO NON PROFIT RESEARCH INSTITUTIONS OTHER THAN UNIVERSITIES OR COLLEGES IN THE FISCAL YEAR 1984.

MR. CHAIRMAN, BEFORE I CONCLUDE MY REMARKS, I WOULD LIKE TO SHARE A COMPLEMENTARY VIEW ON RESEARCH FACILITIES RENEWAL. WE ALL RECOGNIZE THE COMPLEXITY AND MAGNITUDE OF THE INFRASTRUCTURE PROBLEM. THE ULTIMATE KEY TO ITS SOLUTION IS MOST LIKELY GOING TO BE THAT THERE IS NO ONE SOLUTION. WHAT WE NEED TO ENCOURAGE IS THE DEVELOPMENT OF A PACKAGE OF MECHANISMS WHICH WILL RESPOND IN FAIRNESS TO THE DIVERSITY OF OUR RESEARCH AND EDUCATION ESTABLISHMENT AND WILL UPHOLD THE DUAL HALLMARKS

OF OUR UNIQUE SYSTEM - HETEROGENITY AND EXCELLENCE, AND ALSO PRESERVE THE NEEDED FLEXIBILITY WITHIN OUR R&D AGENCIES.

I THINK IT IS CLEAR FROM MY EARLIER REMARKS THAT WE SUPPORT MANY OF THE PRINCIPLES INHERENT IN THE FUQUA BILL. ANOTHER STRATEGY THAT ALSO EMBODIES THESE FOUR PRINCIPLES OF TRUE COST, INVESTMENT, DIVERSITY AND PARTNERSHIP IS ONE WHICH THE WHITE HOUSE SCIENCE COUNCIL'S PANEL HAS DISCUSSED AT LENGTH. THAT IS, TO DEAL WITH SOME OF THE IMBALANCE THROUGH INDIRECT COST RECOVERY. THE PANEL BELIEVES THAT INDIRECT COST SCHEMES SHOULD INCLUDE REALISTIC USE ALLOWANCES COMMENSURATE WITH THE PRACTICES THAT OPERATE IN INDUSTRY TODAY. USE ALLOWANCES, THOSE PORTIONS OF FEDERAL RESEARCH GRANT REIMBURSEMENTS WHICH REFLECT USE AND DEPRECIATION OF UNIVERSITY RESEARCH FACILTIES AND CAPITAL EQUIPMENT, SHOULD BE BASED ON ACTUAL USEFUL LIFE. THE CURRENT LIFETIMES OF 50 YEARS FOR BUILDING AND 16 YEARS FOR EQUIMENT IS UNREALISTIC. IT IS ESSENTIAL THAT UNIVERSITIES HAVE A FLOW OF RESOURCES ADEQUATE TO ALLOW THEM TO PURSUE NECESSARY MODERNIZATION OF THEIR FACILITIES ON A CONTINUING BASIS. THE PANEL BELIEVES THAT CHANGING THE CURRENT APPROACH TO USE ALLOWANCE WOULD HELP PROVIDE THE FLOW OF CAPITAL NEEDED FOR THIS CRITICAL PRIORITY. ALSO THERE SHOULD BE A MEANS TO ENSURE THAT RECOVERED CAPITAL IS USED FOR THIS EXPRESS PURPOSE. FOR EXAMPLE, UNIVERSITIES COULD BE REQUIRED TO MAINTAIN SEPARATE ESCROW ACCOUNTS FOR USE ALLOWANCE REIMBURSEMENTS AND THESE DOLLARS NOT BE WELDED INTO THE UNIVERSITIES' ANNUAL OPERATING BUDGET.

This strategy is an investment approach which calls upon a partnership of shared responsibilities between government and the universities. It recognizes the "real costs of research," requires universities to effectively manage their resources and make long-term capital investments in facilities, and is directly tied to the peer review system that protects and mandates future excellence. However, changes in the use allowance structure and amoritization periods will also cost money and will increase the universities' relative expenitures for indirect costs versus direct costs. The Panel has considered that this approach should be linked to a realistic and fair structure for administrative cost recovery. This component of the "real costs of research" has risen dramatically in recent years and remains the most subjective and contentious issue in the continual controversy over indirect cost reimbursement. Most of the Panel believes that adopting some form of fixed, limited rate for administrative cost recovery combined with relief from many of the reporting requirements is one such rational and fair approach. Instituting a fixed rate policy on administrative costs would decrease indirect cost reimbursement growth that at least in part could offset some of the increase in the use charge allowances.

Once again, this linked strategy underscores that central reality we must face, namely that the total resources at our disposal for research and development are limited. The time has come to re-define our priorities. If there is a priority

PLACED ON MAINTAINING AND MODERNIZING THE PHYSICAL INFRASTRUCTURE OF ONE OF OUR NATION'S MOST VITAL ASSETS - OUR RESEARCH AND EDUCATION ESTABLISHMENT - THEN WE MUST RESTORE THE THREE WAY PARTNERSHIP THAT GUARANTEES LONG-TERM SUCCESS AND LOOK CLOSELY AT CHOICES WHICH ALLOW US TO MAXIMIZE THE PRODUCTIVITY OF THE NATION'S R&D RESOURCES TO BOTH SOLVE THIS PROBLEM AND PROTECT OUR FUTURE.

(MR. CHAIRMAN, I APPRECIATE BEING GIVEN THE OPPORTUNITY TO DISCUSS THE CRITERIA THAT WE BELIEVE SHOULD) BE CONSIDERED IN ANY EFFORT TO ADDRESS THE PHYSICAL INFRASTRUCTURE PROBLEM OF UNIVERSITY RESEARCH FACILITIES. WE BELIEVE THAT HR 2823 IS AN IMPORTANT BILL IN THAT IT AFFORDS THE RESEARCH COMMUNITY THE OPPORTUNITY TO CONSIDER AN ALTERNATIVE FOR ADDRESSING A PROBLEM OF CONCERN TO US AND TO ADDRESS THE APPROPRIATE ROLES OF THE FEDERAL GOVERNMENT, THE STATES, UNIVERSITIES, AND INDUSTRY. WHILE THE ADMINISTRATION DOES NOT FAVOR HR 2823 IN ITS PRESENT FORM, WE NONETHELESS APPLAUD YOUR EFFORTS IN FOCUSING ATTENTION ON THIS IMPORTANT AND TIMELY MATTER.

MR. CHAIRMAN, I WOULD NOW BE PLEASED TO ANSWER ANY QUESTIONS YOU MIGHT HAVE.

Mr. WALGREN. Well, thank you very much for that testimony. How close is the administration to formulating a policy that would provide further resources for research facilities? I gather the indirect cost system, even if you went to a reimbursement for infrastructure costs, would not really address more than the instrumentation side of the facilities question.

Perhaps I'm wrong in that, but do you see the administration moving to supporting a specific program that would address the facilities question?

Dr. HEALY. Well, I think there already has been some motion in the right direction. Back in 1982, A-21 was revised so that interest costs on debts could be included as part of indirect cost recovery, which clearly refers to buildings and not just equipment. That also has allowed universities and research institutions to debt finance many of their facility needs, rather than to simply equity finance those facility needs. And I think that has in fact been a very significant step in the right direction toward helping with the facilities problem.

I think that the administration has also clearly given the signal to the R&D agencies that the instrumentation and facilities issue need attention. But it is the general belief that this is best done in a flexible manner at the agency level.

There is no doubt that indirect cost recovery, specifically the A-21 formula, is also being examined within the administration. And as I mentioned specifically, there is some concern that the amortization time for buildings, as well as for equipment, may be too long. That there's a difference between technological obsolescence and material obsolescence, if you will, and that for a scientific facility, 50 years is probably too long, and something closer to 20 years is probably more realistic, and similarly for equipment, something closer to 8 or 10 years.

And this is being actively discussed within the administration now, and there may be some motion in that direction. And again, that would be an indirect cost approach to dealing with both the facilities themselves, the buildings, the bricks and mortar, as well as equipment.

Mr. WALGREN. I have heard just in informal contact with universities, in particular, nothing but frustration with the indirect cost recovery method. And you indicate that 3 years ago they were given the ability to even fold in the building side of it now.

Has there been measurable progress on the facilities problem within those last 3 years, now that they have had the ability to address it through the indirect cost? And if not, wouldn't that indicate that that mechanism is not a very strong reed to rely on?

Dr. HEALY. Well, just generally, I don't think there should be just one reed to rely on. But with regard to indirect cost, I think a lot of the contentiousness associated with indirect cost recovery has not focused specifically on the infrastructure categories, but more on the administrative cost categories.

With regard to the infrastructure categories, there has always been the ability to take a used charge, but the 1982 rules included the ability to also take the debt financing, the interest charges, so it expanded the opportunity to use the indirect cost mechanism to recover basically the cost of debt financing the facility.

Now, since that really went into effect only in 1982, and since it does take some time to float bonds and build buildings, it is anticipated that we have not yet seen the full impact of that policy on indirect cost. In fact, for many of the university presidents that we have spoken to, through the course of our deliberation in the White House Science Panel, the general feeling we hear or we hear—anecdotally is that there is going to be a projected marked increase in the indirect cost size percentage because we are only now beginning to see the debt financing appear in indirect cost.

So, I think it's still too early to see, but from what I hear we will be seeing it.

Mr. **Walgren**. You indicate that from the administration's viewpoint, they emphasize the need of the agency to decide this without any restrictions on their flexibility. And yet many of these agencies, as I understand it, are not or do not use fully a peer review system.

It's hard, without knowing more than at least a superficial knowledge would bring to this, to have a lot of confidence in the agency judgment, and yet that's what you're indicating the administration would like to see maximized in this area in terms of what they do.

Do you feel that Congress should be comfortable with the processes that many of the agencies use to decide the total disposition of the facilities problem, either 100 percent financing or 100 percent financing here, without some real structures that we would know that they're operating under?

Dr. **Healy**. Well, I think that if I could start with a very broad answer, and one that is truly not political and not specific to this administration, I think it is fair to say that our R&D agencies that invest in the not for profit private sector have done a spectacular job in building up a jewel of the scientific enterprise out there. And I think that they have done it with the resources that have been made available to them, and that one can only marvel at the truly unique science and technology base we have in our universities and colleges, and our private institutions, research institutions.

And we have a unique jewel here that has rivaled the world. And I think that was done by a system which from the very beginning, from the Vancover-Bush Report, was built on the principle of allowing the opportunities and excitements in science to direct the flow of money in that university based investment. And I think the agencies for the most part have carried that out through a merit based review system. I think probably a merit based review is a better word than peer review.

I think that at the present time there has been a tendency of all parties concerned, over the past 10, 15 years, to let the bricks and mortar slide a bit, and in part I think that is a natural tendency when you're faced with an exciting piece of research to be done. You can ignore painting the walls or let some of the infrastructure modernization go if you're in the midst of an exciting scientific enterprise. There's always the tendency to invest in ideas and in clever people and in creative talent than to invest in a new piece of equipment if you can make do with an old piece of equipment because you're clever.

So, I think it is a very, very normal and healthy occurrence that developed in the science and technology establishment.

I think when you realize that we have a $50 billion research investment on the part of the Government, and less than $6 billion of it is spent at our universities, again I think they've done a splendid job in developing a strong enterprise.

The big issue, though, is that the administration is concerned about the question of flexibility. That if one box is in, the research budget with set-asides, whether it be a 1-percent set-aside or a 10-percent set-aside, that will limit the flexibility of the agencies to set their own priorities—which has been an incredible strength of the research enterprise that we have invested in—that the research enterprise can suffer.

Mr. **Walgren**. Thank you. The Chair would recognize Mr. Cobey.

Mr. **Cobey**. Thank you, Mr. Chairman. I appreciate this fine testimony, and of course commend the committee chairman for going forward with a look at this. I'm glad to see that you're applauding the merit based evaluation. I don't want to see us get involved in redistribution of the wealth program, and I don't think that this is that at all. But we certainly have to protect the great research institutions of our country and those facilities.

And I just wanted to have one question before I have to leave. The universities pool of administrative costs have dramatically increased. Could you educate me a little bit on what are the primary reasons that those administrative costs have risen, and to what extent they have risen so dramatically?

Dr. **Healy**. Well, the extent is that they have grown faster than the direct cost of research by almost a factor of two.

Mr. **Cobey**. Since when?

Dr. **Healy**. Since 1972. Roughly between around 1972 and 1982 the direct cost of research increased roughly 150 or 60 percent, and the administrative costs increased in excess of—the indirect cost increased in excess of 300 percent. Now, part of that was due to energy demands within the indirect costs, but the bulk of it during that time was administrative costs.

Now, there are a lot of reasons that go into it, and there is a lot of difference from one university to the next on that administrative cost recovery. One possible factor, that I think we have discussed in the Panel, is that it is the system of a cost reimbursement as opposed to a true need reimbursement. That if there is an administrative cost that, from an accounting perspective, appears legitimate, it is reimbursed. Whereas on the direct side, through the merit review system, there is very close scrutiny by other scientists who are doing that research of exactly what piece of—what a piece of research really needs in terms of technical help, equipment, personnel. So, I think that is one factor.

I think there are many others that have to—weigh in. There's certainly no doubt that the Government escalation of paperwork has contributed to the need for the universities to increase their bureaucracy. Effort reporting is a classical example of accountability requirements that has been placed on the universities that has led, in and of itself, to increased administrative costs.

The requirement for documenting cost sharing in some institutions is apparently as costly as the cost-sharing percentage itself.

So, it's a very complicated issue, a thorny issue, and a contentious issue, and there's no one simple explanation for it.

I think that the universities are as concerned about it as the Government is, but I think we haven't yet arrived at a simple solution for it.

Mr. **Cobey**. Thank you, Dr. Healy.

Mr. **Walgren**. Mr. Barton.

Mr. **Barton**. Thank you, Mr. Chairman. I'm proud to be a cosponsor of Chairman Fuqua's bill, and I think this is a piece of legislation that is vitally needed to maintain our science and research infrastructure, our colleges and universities. The thing that strikes me as being most impressive about this is that it is a matching program. We're going to try to generate the funds for it through existing resources, and we've made a provision that it doesn't all go to the same universities and institutions that have received a lion's share of funding for so long.

So, I don't really have any questions for you, Dr. Healy. I know that this legislation is, as Chairman Fuqua said, totally open for amendment. I have sent a copy of the bill down to Texas A&M, which is in my district, and I'm sure that they will have some amendments as the hearings progress. But the folks at A&M were very positive about this legislation.

I look forward to working with the other members of the subcommittee and the full committee as it makes it way through the Congress.

Mr. **Walgren**. Thank you, Mr. Barton. Chairman Fuqua.

Mr. **Fuqua**. I have two points, Dr. Healy, that I've gathered from your testimony. One was on the lack of flexibility for the agencies. I assume you were referring to the 10-percent floor. It's my experience around this place that if we don't put in a floor, then they won't get anything, and that's the reason for that. We do not tell them how they should make the grants, as I noted during my presentation to the subcommittee.

I think that if we do not put in some type of floor, that we'll wind up with legislation on the books and nothing happening. And the 10 percent, while it may be an arbitrary figure—and Mr. Lujan even thought it maybe should be more, and I think that was the thrust of his remarks—but that's 5 percent below what industry does. Industry—squirrels away about 15 percent, or they feel that's the target area that they should work in. So, I hope that you people will take that into consideration in reviewing the bill.

The other thing is about the indirect cost. That is certainly, may be a long range way of accommodating the problem that we have, but not in the short range. Because I think in the short range it will still be them that ain't got, won't get. Plus, we seem to be always at the whims, not only in this administration, but other administrations, of some knife cutters at OMB, that they decide periodically—and they go through cycles not limited to one party or the other—but some of the gremlins down at OMB that come up with this theory every few years they have to revise that circular A-21. And if it gets to look like there's too much indirect costs, in order to save money on the budget they reduce this back down, and then there's a new cycle and a lot of agitation among the academic community.

The second problem I see with that is that you run into an inherent conflict among the investigators at universities and the university administration, you put them in direct head to head conflict, because investigators say "Hey, I brought this $10,000 grant here, and you're taking $4,000 out of my grant for overhead costs to go to some crazy bill that I don't care anything about. I want my full amount of money." And that is one of the problems. The other is the long range problem with that.

If we could be assured that indirect costs would truly reflect that over the long haul, then that may be part of the solution. But the immediate problem that we have now, is we have a real critical problem and we need to try to address it, and that's what we're attempting to do in the bill.

You may wish to comment, I was just trying to give you the rationale for those two issues being in the bill and why they were there.

Dr. **Healy**. No, I certainly appreciate that. Again, I think that the principles that you raise are the key ones. I think one of the concerns is that when prescriptions like that become carried out—for example, 5 years down the road, when there's this 10-percent set-aside in the R&D agency budget, and maybe by that time something else has come along or the infrastructure problem isn't as pressing, or there are other needs within the science establishment that might want 2 percent of that 10 percent to go somewhere else—there doesn't seem to be the flexibility to deal with that.

And when one looks at a 10-year haul, I think concerns about locking in a rigid formula even becomes of greater concern.

Mr. **Fuqua**. Thank you, Mr. Chairman.

Mr. **Walgren**. Thank you, Mr. Fuqua. You mention in here the importance of having any infrastructure program plan be a long-term investment. And then the question comes, how do you apply a relatively strict criteria of merit on a long-term investment?

At first blush it would seem to have nothing to do with the people involved, because any individual researcher may be gone tomorrow for either personal reasons or for poor health. And so, you're—what sort of merit based factors do you apply to a long-term investment?

Dr. **Healy**. Well, let me go back again to the example of indirect cost recovery. If the university floats a large bond issue, and for which it incurs a substantial debt, and let's say it's a 20-year bond or a 10-year bond, that means over the long haul it has incurred a debt which is a long-term investment in its infrastructure. It is banking on the fact that it is going to maintain the excellence in science and its ability to acquire research dollars that will allow it to pay back that debt and the interest on that debt over the long haul.

So inherent within an indirect cost recovery scheme, which is linked to the merit based system, virtually all of those grants are given out by merit, scientific merit review. You are basically making a long-term investment and a long-term commitment on our own belief that you're going to maintain the standards of excellence you have today. If you don't think you have those standards of excellence, and you're not willing to gamble on a long-term investment for the quality of research that your institution is going to be generating 10 years down the line, I suspect you wouldn't make that initial investment up front.

Mr. **Walgren**. But if we're talking about providing Federal funds in any kind of an other than current operating expense basis, then we're the ones that have to make that bet. I can understand a university betting on itself and incurring a long-term debt because they bet on themselves, and they believe in themselves. But how do we, as a Government, bet on one or another when we know why they're making that bet—you know, there's no choice for them. They're not choosing to do a long—you know, if you're the chancellor at the University of Pittsburgh, you're not choosing to invest in the University of Pennsylvania and go into the bank for a long-term bond. You're not making any choice.

How do you make choices when you're really looking way down the road? Some of the near-term things that we would use in the National Science Foundation—a particular project, a particular expertise, certain people at a certain place at a certain time—that you might be able to project for 2 years or 3 years, but how do you project 20 years?

Dr. **Healy**. Well, let me make two comments in response to that. First, you may think the universities are betting just on themselves when they float that 10- or 20-year bond issue, but I assure you they're betting on the Federal Government, and the fact that the Federal Government will continue to support research at least at the level and at the pace that it has in the past.

Mr. **Walgren**. Well, yes, that's inherent in the bill. But my point is that they're not moving their activity from one site to another site depending on merit. And when we approve Federal funding we must make a choice, or the agency must make a choice. And how do you do that?

Dr. **Healy**. Well, I think that you're identifying probably one of the biggest causes of perceived instability on the part of universities, vis-a-vis the way the Federal Government invests in research. And that is the budget, the appropriations come up every year and there's never certainty about what the next budget year is going to look like. And yet, universities, by their very nature, and research by its nature, is a long-term investment.

The Federal Government has never bought into the notion of long term, multiyear funding commitments in any substantial way for the research enterprise. It continues to do it on an annual basis because this is the way the Government works.

Mr. **Walgren**. But yet you say we must, we must make a long-term investment, a stable, long-term commitment.

Dr. **Healy**. Yes; and I think we can just like one does in ones own family finances. You can make a long term, stable commitment as the Federal Government knowing that if the resources are there, this is going to be one of your highest priorities. You may not be able to project a fixed appropriation for the next 10 years, but I really do believe that our Federal Government has, regardless of party, regardless of administration, has made a commitment that science and technology is one of the highest priorities for the country.

I think that if the scientific community were just assured of that, that science and technology was a high priority, that it was something that the Federal Government recognized to be a long-term investment, I think that would quell some of the discord or unease, that exist in tension in the partnership, if you will.

For that reason, I think something like this bill, which also doesn't guarantee 1 year to the next, they're still dependent on the appropriations of the individual research agencies. And if their budgets don't increase, the infrastructure component falls to zero.

So, there isn't a guarantee for 10 years, even though it's a 10-year bill, but I think that a bill such as this, and I think the deliberations of this subcommittee, are important in elevating the importance and the recognition that science and technology is important to the Nation as a whole and not just to the scientific community.

Mr. **Walgren**. Well, I'm just curious, in the discussion of this, how that quality of merit—which I don't mean to undermine—but how do you apply that as a factor when you talk about very long term investments that go beyond the individual research project, the individual people involved in the enterprise at any one time?

Dr. **Healy**. Well, remember most of the time when we really talk about merit, we tend to really focus on merit of individual projects, which in aggregate compose the net investment that the Federal Government makes in a university. And if one believes in the 40-year history, it does appear that the aggregate R&D dollars that go to various institutions does, in someway, reflect merit or merit review.

That does not mean, however, that small institutions haven't been able to compete extremely well in our merit based system. And I think that there are marvelous examples of institutions all over the country coming up, and some in a relatively short period of time, because of merit and merit alone.

Mr. **Walgren**. But I wonder how they would do in a program whose focus was long-term investment. I can understand them coming up with a competitive position with respect to an individual research proposal, but how does an institution that sort of doesn't have some of these facilities, for starters, compete in the long-term investment? And isn't it really a question of keeping the commitment?

I was recently down at Oak Ridge National Laboratory, where they have a large display about how they just created Oak Ridge out of whole cloth, essentially. There was nothing there before they decided there would be something there. And now what's there is tremendously excellent.

And so, isn't it more a function of making the decision to place X in this place, or that place, and then keeping the commitment to fund it properly?

Dr. **Healy**. Well, I think traditionally that in fact has happened. But those decisions to put an institution on place X or place Y has been made on a regional basis. And I think private philanthropy, research communities, States, have usually taken the lead in making those decisions, and to have made them with incredible wisdom.

And I think you can see university systems that are State based all over the country that have developed in a particular place because of a regional commitment. The State of Texas, the State of

California are very good examples of relatively young university structures that have grown up to astounding excellence in a short time because of regional commitment.

Mr. **Walgren**. So the excellence is more tied to commitment than it is to what they start with.

Dr. **Healy**. Yes; but what I'm suggesting is that traditionally our university system has worked so well, in part possibly, because the commitment has come regionally, and that regional commitment has been leveraged with Federal investment. But that has not come centrally as so many European universities are based. It has not been a central decision to have a U.S. university system that is controlled centrally.

But the diversity and heterogeneity of our system—and I think that's part of its great strength—reflects the fact that the decision to put X in such a place has been made on a regional and local level, by private individuals in some cases, and in some cases by States. I wouldn't tamper with that, in my opinion.

Mr. **Walgren**. One of your reservations about the Fuqua bill is that in the administration's view it gives the Government the responsibility for setting the priorities with respect to facilities modernization. And you would like that responsibility to be shared. And, of course, the bill does provide for the driving engine to be private or local proposals.

But when you say that, under this bill the Government, the Federal Government, is taking the responsibility to decide what happens, isn't that what happens now? The Defense Department decides to put a facility in a certain, just plop it down, place. And the Federal Government has decided totally in that instance what the facility structure is going to be.

And so, is that really a legitimate reservation to have about this kind of a matching fund, relatively diverse, proposal?

Dr. **Healy**. Well, I think for the Federal laboratories that may be the case. But I think for our private universities, for our universities and colleges—which are only, as I said, about $5 or $6 billion in that whole R&D investment—the Federal Government has not been the driving force in deciding what facilities go where, and how much money is put into facilities. That has largely been a decision which is made by the individual institution, as I said, to gamble on their future, or to raise the equity to put up a facility with the faith in themselves that they can recover a substantial part of it through use charges.

But that has traditionally not—in our university system in this country, has not traditionally been a decision by the Defense Department or by the Congress or by a research agency.

Mr. **Walgren**. But even those decisions are closely tied with available Federal funding.

Dr. **Healy**. That's right.

Mr. **Walgren**. And in making those choices, the Federal Government essentially decided the——

Dr. **Healy**. I think the key choice is that the Federal Government decided that it was going to invest in university-based research because it thought it was the best way to get the highest quality research done for civilian research. That was the key choice.

Mr. **Walgren**. There's a general question of—if you take all Federal research and development, as opposed to just that done in universities—what percent of Federal funds should we be investing in academic research facilities? Is the academic participation presently striking the proper balance?

And if you look at the overall scientific enterprise, what percentage of our efforts should go into university facilities?

Now the bill, as I understand it, takes 10 percent or would move 10 percent of what is presently being spent in academic research now. But that isn't necessarily the proper measure of what the proper investment in academic facilities would be.

I would be curious what the administration's science policy people would say, what answer they would give to that question. Given the overall scientific investment by the Federal Government, in all its entities, what percentage should be directed toward the renovation of the university scientific—or academic scientific facilities?

Dr. **Healy**. Well, first just a point of clarification. It's my understanding that the bill in its present form does talk about new money that first year, almost $500 million of new money. And I think that if it didn't have that money—this is my impression from hearing numerous opinions on this—that if this were just a 10-percent set-aside, that this bill would probably be very unpopular. That the new money element, which is carried on presumably throughout the 10-year period of time, is almost a keystone of this particular piece of legislation, and probably one of the more difficult aspects of it, because the question is, is there new money available and where is it going to come from.

With regard to your much broader question, I think it's a very important question, and I'm not sure that it's an easy one to answer or that it can be answered simply. The White House Science Panel has deliberated on this for many hours. And I can tell you that there is no one answer or no one administration position or no one White House Science Panel position that I can relate.

I would just suggest to you that in the civilian R&D investment, which is in the range of about $20 billion or a little more than that, that the investment in university-based research is in the range of about $5 to $6 billion. And I think one could ask the question, is that the appropriate distribution of research investment if in fact we're to view the university-based research, the basic research done in those universities, as among the highest priorities in our R&D investment?

A lot of that money, of the other $16 or so billion, goes into the Federal laboratories. And Mr. Packard recently performed a report which was delivered to Dr. Keyworth and to the President on the university investment—the Federal laboratory investment, and they did come up with some recommendations; that some of the money spent in that particular area, there could be some economies there.

So, I just suggest to you that that kind of question needs a very, very broad look, and it is a very, very tough one, and always runs the risk and the concern of robbing Peter to pay Paul.

Mr. **Walgren**. If you were to feel that the investment in this area would properly be more than 10 percent of the present university-based research, then this approach would, at that point, simply become one of the package of mechanisms that you indicate we need. So, to the degree that the need is greater than 10 percent of what we're presently spending in university research, this would certainly not have to be looked on as an all inclusive method. And, therefore, any reservations about whether it over-emphasizes this responsibility or under-emphasizes that participation could be compensated by the other mechanisms in your package.

Would that not be true?

Dr. **Healy**. The only concern here is that 10 percent is a pretty hefty sum in the R&D in a Federal agency's budget. And to really earmark that, that 10 percent dollars, and say that for the next 10 years, 10 percent of that budget must be spent only on facilities and instruments could be unduly restrictive and binding, and could in fact hurt the research enterprise.

The 10 percent is something of an arbitrary number. Maybe the number should be higher, maybe it should be lower. But I think a concern is should there be some flexibility. If one is to come up with a formula, should there be some greater flexibility.

I understand Chairman Fuqua's concern that if you don't put a number in, none of the money will be spent. But I think that the risk you run when you put a number like that in is that you can waste money, and you can hurt the research investment because you introduce an inflexibility. And if research needs anything, it needs the flexibility so that it can pursue the opportunities as they arise.

And, in fact, the budget in recent years, in general, in all the agencies have probably suffered a little too much from earmarking and set-asides.

Mr. **Barton**. Mr. Chairman, I'm going to have to go to another meeting. I have one question if you'd yield, please.

Mr. **Walgren**. Sure. The Chair recognizes the gentleman, Mr. Barton.

Mr. **Barton**. Dr. Healy, in your testimony on page 9 you say that, "The Administration has serious reservations about a formula approach"—which is what you've been discussing with the chairman—"which restricts the flexibility of Executive agencies to make priority choices in support of R&D, and believes that these agencies should not be constrained anymore than necessary by fixed and binding formulas.

"The Administration believes that the Federal Government, through its research and development supporting agencies, should work with the universities, industry, and the States to devise creative, flexible, and long-term mechanisms to address the need for research facilities."

I don't think anybody on the committee disagrees with that. Are you prepared today or in the near future to discuss some of these creative, flexible, and long-term mechanisms? If you are, I assure you that I'll be more than happy to work with you and Chairman Fuqua and subcommittee Chairman Walgren to incorporate those into the bill.

Dr. **Healy**. Well, I think that's precisely why it is very useful to have this bill on the table, because I think it will help to stimulate some of the dialog. There have been a lot of creative suggestions that have come up, and the chairman spoke about the National Academy of Science's facilities roundtable earlier last week. And I think that the community is stimulated to think about ways of addressing this problem, that provide flexible and creative means for addressing this, and probably multiple dimensions to the approach.

And I think that probably in the course of hearings on this bill you will hear, hopefully, many of those suggestions. The one that I included in my testimony I think is the one that the White House Science Panel has discussed, which is using the existing indirect cost mechanism and revising it so that it can partly deal with the problem. By no means is that a total solution.

Mr. **Barton**. Well, the concern that I have—and I am as reluctant as anybody to adopt a specific formula, a specific set-aside or percentage allowance or whatever. But it appears to me, in my investigation before I agreed to cosponsor the bill, that this was one of those things that every year, at the end of the year, the community, the research community, the university community said yes, we need to put some more money into the facilities, but we've got this project and these people need to be paid, so we'll do it next year. And they do the same thing the next year and the same thing the next year.

And it's very similar to somebody that lives in a forest, and they begin to cut down the trees for heat and lumber, and pretty soon they don't live in a forest anymore. And they say, by golly, I wish we would have saved some of those trees.

And we are a preeminent nation in the scientific community, and we are because we have our research and development activities. And we need to address this problem, we need to say that this is a serious problem, the current system is not addressing the problem. And if it takes spending a half a billion dollars for the next 10 years, and some specific set-asides that are merit based, that are cost sharing, that does require a partnership, then I think that we may have to do it. But I will be willing to work with you and the other members of this committee to try to address—and we don't want to come up with a formula that wastes money.

I don't want this to turn into a deal where we've got $400,000 and let's buy 3,000 IBM typewriters in September. But it just doesn't appear to me that we have addressed the problem under the current system, and this is a good beginning place.

Thank you, Mr. Chairman.

Mr. **Walgren**. Thank you, Mr. Barton. Dr. Healy, thank you very much for your testimony this morning, and we look forward to talking with you about this and your colleagues in the future.

The third witness today is Dr. Frank Press who, as you all know, is the president of the National Academy of Sciences. Dr. Press, welcome to the committee. And as you know, at the outset, your written testimony will be made part of the record in its entirety, so feel free to select portions or particular points that you'd like to stress. We're happy you're here and pleased that you have made the effort to give us your views on this subject.

STATEMENT OF DR. FRANK PRESS, PRESIDENT, NATIONAL ACADEMY OF SCIENCES

Dr. PRESS. Thank you, Mr. Chairman. In your letter of invitation you asked me to discuss H.R. 2823 in the context of the academic research facilities problem generally. I'll frame my remarks accordingly.

My first comment is: "At long last." The deterioration of academic research facilities has been chronicled for over a decade. We have had successive reports documenting the need, outlining the damage being done to the national research capacity, and pointing to the contradiction between the Nation's belief in science and technology as essential to economic strength and national security, and its denial of the funds to replenish an aging infrastructure.

These reports have had little impact. Between the zenith of Federal support in the 1960's and today, Federal obligations to universities for R&D facilities in constant dollars declined 90 percent. There is today virtually no Federal funding for academic research facilities other than specialized national facilities.

Why did it happen? A quick answer is that the facilities boom of the 1960's was an aberration, just as the bust of the 1980's is now. There is some truth in that, although I would point out that even in the 1960's the Federal Government bore only about a third of the cost of academic R&D facilities, with the rest provided by State governments, general funds, endowments, capital construction drives, and the like. Today, the Government's share is about one-sixth.

Another possible, somewhat ironical, answer to what happened lies in the unique features of our research system. Those features, which I believe are directly responsible for the global primacy of American research, are well known to this committee. Federal support goes in the main to individuals, not institutions. Support is based on quality, not rank or affiliation. It is given on a cost reimbursement basis. It is project based, and it tends to be short term, for a couple of years.

While those features are salutary, and must be retained, they have, by their concentration on projects and individuals, hidden broader needs of the research system. And we've seen that most damagingly in the case of facilities for academic research.

The bill under consideration today is then a palpable recognition of the systemic needs of the research system. For that, I wholeheartedly commend Chairman Fuqua for sponsoring it. It is to be hoped that your committee's deliberations on this measure will initiate a discussion of the issues in the search for an acceptable framework for action.

As this committee knows, the facilities issue is a difficult one, not only financially but conceptually. By conceptually, I mean the role of technical review in deciding what facilities ought to be supported and where they are to be built. I do not support the practice of direct appropriations for specific facilities.

Quoting from remarks I made last spring at the AAAS R&D colloquium, and I quote:

> Suffice it to say that the practice has the potential for enormous damage to the research system. And suffice it to say that some universities have gone this route in

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part out of desperation, owing to over a decade of undercapitalization of academic facilities.

However, by the same token, the scientific community must be sensitive to the fact that project grants and facility support are not commensurate. In particular, many in the scientific community, as in the Government, need to understand the role of what is now called comprehensive merit evaluation in funding large facilities.

Again quoting from my AAAS talk:

> In individual research grants, peer review largely decides; in funding large facilities, evaluation by experts narrows the list of candidates. The actual decisions emerge from a comprehensive merit review, incorporating political, geographic, economic, and other policy elements. That was true in the case of Fermilab. It will be true in the case of the new synchrotron radiation facilities to be built. It will certainly be true in the case of the superconducting super collider.
>
> These are national facilities. And that same comprehension of the more limited, but vital role of evaluation needs to infuse the present problems with facilities appropriated from the floor of Congress. We need a common understanding that scientific evaluation is a necessary, but still only one, facet of deciding which facilities to support and at what institution.
>
> The amount of money involved in such facilities and the implicit commitments to support their long-term operation makes political and other factors inescapable. What peer review can do is to assure that any facility finally selected merits its support in terms of the overall health of scientific research.

As Chairman Fuqua knows, the concept of comprehensive merit evaluation for facilities was supported, albeit not without some heated dissent, at a meeting at the National Academy last week on academic research facilities. That meeting was cosponsored by the National Science Board, the Office of Science and Technology Policy, the Academies of Sciences and Engineering, and the Government-University-Industry Research Roundtable.

With that as background, I believe the bill to be on target and realistic. It is on target for the reasons I just cited. It is realistic in confronting the economic realities of the 1980's. In particular, it is realistic in forcing the Congress and the research community to make some hard choices.

Those choices will have to be made at several levels; the overall Federal budget, project grants versus infrastructure needs, State and university priorities, the use of the indirect cost recovery mechanism, and the like. Those choices are usually difficult, but now they've become quite painful, as our Nation is pinched by the need to maintain research excellence at a time when neither governmental budgets nor university enrollments are likely to grow significantly.

As Congressman Fuqua noted, the bill's importance lies not only in its contents, but also that it will be a focus for obtaining consensus agreement within the Congress on the facilities problem. Whether the bill before us or a variant ultimately obtains congressional passage and Executive support is less important than the fact that it forces the Federal Government to confront a problem in terms familiar to it; that is, in terms of budgets, specific agencies, and fiscal years. Against that, let me commend other aspects of the bill.

After a de facto abandonment of facilities support by the Federal Government, the bill reestablishes an identifiable budget for capital outlays. In doing so, it may dampen the direct appropriations issue, for, if the bill passes, there will, in principle, be six agencies to which universities or colleges seeking to build or modernize their research plant can turn. Academic institutions desperate for facilities funding will now have a real alternative.

The up front funding provided for in this bill means that it's possible to reconcile agency needs with academic capacities. That feature is not trivial given the spreading recognition that a strong research force is vital to the Nation's future economic strength and national security.

It has the potential both for reducing the uncertainties of facilities funding in the annual budget battle, and for stabilizing capital outlays.

Finally, the bill's emphasis in the outyears on matching funds is appropriate to the times. Of course larger universities are likely to have an easier time obtaining matching funds than smaller ones. However, by the same token, those universities beginning to emerge as strong research centers will have access to facilities funding that may now be simply unobtainable.

I should add that while the bill is welcome, the magnitude of over a decade of neglect is so large that we need to think of ways to complement the Fuqua approach. Some of these additional funding modes were discussed at last week's meeting at the Academy. They include both equity and debt financing, and this bill is an example of the former.

Tax exempt and taxable bonds and notes, Government loans, and Government guaranteed bonds are all examples of debt financing. And there are within this taxonomy a great many interesting ideas worth exploring. One example is the establishment of an independent, nonprofit corporation, which would be given a startup trust fund by the Federal Government. Such a corporation would help academic institutions by providing credit support or leveraging for capital borrowings in the tax exempt market.

The particular ideas are less important than what they imply: That the research community is now intensively investigating new financial arrangements for facilities; that is, arrangements to leverage limited Federal funds. However, universities need something to leverage, and this bill offers them that.

That facilities issues pose both short-term and long-term problems, and strategies for both time frames must be explored. That the issue cannot simply be dropped upon the Federal Government, and other sectors, such as States acting individually or through compacts, need to address it.

Let me briefly turn to some concerns with the bill. I do so within the context of supporting its goals, and I do so within the context of what Michael Collins said when he was asked how the National Air and Space Museum was built on time and under budget. His response was that, "The perfect airplane is still in the hangar." The bill may not be the perfect airplane, but I hope it flies.

One concern is with the implicit tithing of agency R&D budgets. I know that the hope is to have facilities funding be an add-on rather than a set-aside. But that sentiment is not expressed in the bill for fiscal 1988 and beyond. Of course, given the millstone of the Federal deficit, any attempt to write in an add-on would almost certainly doom the bill.

I do feel that the authorization funds for fiscal 1987 must be retained as a trigger mechanism for allowing the 10-percent set-aside in the out years. I also share Chairman Fuqua's hope that the unhappiness, which many faculty members will have with the 10-percent allocation, will be mitigated by an overall growth in the basic research budget of the Federal Government over the next decade.

A second concern is that, as I pointed out in Senate testimony earlier this year, the level of unencumbered project research funds available to the NSF has declined in the current budget.

Given that, the committee might well consider whether each agency might be given some leeway in how it allocates facilities funding out of its R&D budget. Needs tend to be uneven, by field and other elements. Certainly a 10-percent allocation for facilities funding is needed and would help in some areas, but might be potentially damaging in others.

The committee might acknowledge variable pressures on agencies for facilities funding by building greater flexibility in the bill's allocation funding. Perhaps, as was suggested at the meeting last week, an agency, rather than being immediately required to provide 10 percent of its R&D funds, might be allowed to move up to that level over a fixed time, say 3 to 5 years. Also one might consider a local option, that is, campus by campus flexibility in the use of this approach.

I should also point out that the bill provides for the construction and modernization of facilities, but not for their operation and maintenance. This plunges us into the treacherous terrain of indirect costs, and the committee might quite wisely feel that the issue needs to be taken up separately. I see no reasonable way to avoid it.

A weakness of the facilities programs of the 1960's was their lack of foresightedness concerning maintenance. That is, in allowing either for the availability of maintenance funds directly or by recovery of such costs out of the indirect charges against research grants. Given the magnitude of the need, universities will most certainly have to use significant debt to fund facilities with attendant pressures on their indirect cost rates.

Mr. Chairman, I repeat again that my comments should be set in the context of my overall support for this bill. The universities are imaginatively and intensively seeking to restore their aged research plant. According to a recent NSF report, universities are planning to spend about $1.3 billion over the next 5 years on new facilities. That expenditure rate doubles that of the previous 5 years. That money in the main will come from general funds, State appropriations, endowments, and the like.

In other words, rather than the universities leaning on the Federal Government, one could say that the reverse is true. For almost two decades the Federal Government, in effect, has harvested a research system while abandoning its obligations to support the structures which house the laboratories, the instruments, and the people who do the work.

The bill is welcomed and it is overdue. Thank you.

[The prepared statement of Dr. Press follows:]

Testimony

by

Frank Press

President

The National Academy of Sciences

on

The University Research Facilities

Revitalization Act of 1985

before the

Subcommittee on Science, Research, and Technology

Committee on Science and Technology

U.S. House of Representatives

July 30, 1985

Room 2318

Rayburn House Office Building

Mr. Chairman, in your letter of invitation, you asked me to discuss H.R. 2823 in the context of the academic research facilities problem generally. I'll frame my remarks accordingly. My first comment is: "At long last." The deterioration of academic research facilities has been chronicled for over a decade. We have had successive reports documenting the need, outlining the damage being done to the national research capacity, and pointing to the contradiction between the nation's belief in science and technology as essential to economic strength and national security and its denial of the funds to replenish an aging infrastructure.

These reports have had little impact. Between the zenith of federal support in the 1960's and today, federal obligations to universities for R&D facilities in constant dollars declined 90%. There is today virtually no federal funding for academic research facilities, other than specialized, national facilities.

Why did it happen? The quick answer is that the facilities boom of the 1960's was an aberration, just as the bust of the 1980's is now. There is some truth in that, although I would point out that even in the 1960's the federal government bore only about a third of the cost of academic r&d facilities, with the rest provided by state governments, general funds, endowments, capital construction drives, and the like. Today, the government's share is about a sixth.

Another possible, somewhat ironical answer to what happened lies in the unique features of our research system. Those features — which, I believe, are directly responsible for the global primacy of

American research -- are well known to this Committee. Federal support goes in the main to individuals, not institutions. Support is based on quality, not rank or affiliation. It is given on a cost-reimbursement basis. It is project based. And it tends to be short-term, for one to three years.

While those features are salutary and must be retained, they have, by their concentration on projects and individuals, hidden broader needs of the research system. We've seen that in instrumentation. We've seen that in a lack of adequate mechanisms, now being corrected, for a fluid exchange of knowledge between research sectors, especially between academia and industry. And we've seen that most damagingly in the case of facilities for academic research.

The bill under consideration today is then a palpable recognition of the systemic needs of the research system. For that, I wholeheartedly commend Chairman Fuqua for sponsoring it. It is to be hoped that your committee's deliberations on this measure will initiate a discussion of the issues in the search for an acceptable framework for action.

As this Committee knows, the facilities issue is a difficult one, not only financially but also conceptually. By conceptually, I mean the role of technical review in deciding what facilities are to be supported and where they are to be built. I do not support the practice of direct appropriations for specific facilities. Quoting from remarks I made last spring at the AAAS R&D colloquium, "suffice it to say that the practice has the potential for enormous damage to the research system. And suffice it to say that some universities have gone this route in part out of desperation, owing to over a decade of undercapitalization of academic facilities."

However, by the same token, the scientific community must be sensitive to the fact that project grants and facility support are not commensurate. In particular, many in the scientific community, as in the government, need to understand the role of what is now called comprehensive merit evaluation in funding large facilities.

Again quoting from my AAAS talk, "in individual research grants, peer review largely decides; in funding large facilities, evaluation by experts narrows the list of candidates. The actual decisions emerge from a comprehensive merit review, incorporating political, geographic, economic, and other policy elements. That was true in the case of Fermilab. It will be true in the case of the new synchrotron radiation facilities to be built. It will certainly be true in the case of the superconducting super collider.

"These are national facilities. And that same comprehension of the more limited but vital role of evaluation needs to infuse the present problems with facilities appropriated from the floor of Congress. We need a common understanding that scientific evaluation is a necessary, but still only one, facet of deciding which facilities to support and at what institution. The amount of money involved in such facilities and the implicit commitments needed to support their long-term operation makes political and other factors inescapable. What peer review can do is to assure that any facility finally selected merits its support in terms of the overall health of scientific research."

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As Chairman Fuqua knows, the concept of comprehensive merit evaluation for facilities was supported, albeit not without some heated dissent, at a meeting at the National Academy last week on academic research facilities. That meeting was cosponsored by the National Science Board, the Office of Science & Technology Policy, the Academies of Sciences and of Engineering, and the Government-University-Industry Research Roundtable.

A second conceptual issue embedded in the bill before us is the attitude of the federal government toward the research it funds. It is commonplace to label support for fundamental science and engineering as an investment. But that truism is often belied by practice. The question is whether federal accounting principles recognize the inherent uniqueness of a research endeavor. There is a tendency to apply the same accounting principles in supporting university research as in awarding procurement contracts. And that tends to devolve into product orientation. That is, what is produced for a given amount of support? It tends to force rigid adherence to a proposed line of work and budget. And it tends to lead to neglect of the components of successful research -- such as flexibility, mid-course changes, replacing rapidly obsolescent equipment, training facilities, people to run instruments, and so forth. Fundamentally, should the governmental attitude be one of purchasing research results or of investing in a research system?

With that as background, I believe the bill to be on target and realistic. It is on target for the reasons I just cited. It is realistic in confronting the economic realities of the 1980's. In particular, it is realistic in forcing the Congress, and the research community, to make some hard choices. Those choices will have to be made at several levels: the overall federal budget, project grants versus infrastructure needs, state and university priorities, the use of the indirect cost recovery mechanism, and the like. Those choices are usually difficult; but now, they've become quite painful, as our nation is pinced by the need to maintain research excellence at a time when neither governmental budgets nor university undergraduate enrollments are likely to grow significantly.

As Congressman Fuqua noted, the bill's importance lies not only in its contents, but also that it will be a focus for obtaining consensual agreement within the Congress on the facilities problem. Whether the bill before us or a variant ultimately obtains Congressional passage and Executive support is less important than the fact that it forces the federal government to confront a problem in terms familiar to it; that is, in terms of budgets, specific agencies, and fiscal years. Against that, let me commend other aspects of the bill:

- After a de facto abandonment of facilities support'by the federal government, the bill reestablishes an identifiable budget for capital outlays. In doing so, it may dampen the direct appropriations issue, for, if the bill passes, there will, in principle, be six agencies to which universities or colleges seeking to build or modernize their research plant can turn. Academic institutions desperate for facilities funding will now have a real alternative.

- The "up-front" funding provided for in this bill means that it's possible to reconcile agency needs with academic capacities. That feature is not trivial, given the spreading recognition that a strong research force is vital to the nation's future economic strength and national security.
- It has the potential both for reducing the uncertainties of facilities funding in the annual budget battle and for stabilizing capital outlays.
- Finally, the bill's emphasis in the out years on matching funds is appropriate to the times. Of course, larger universities are likely to have an easier time obtaining matching funds than smaller ones; however, by the same token, those universities beginning to emerge as strong research centers will have access to facilities funding that now may be simply unattainable.

I should add that while the bill is welcome, the magnitude of over a decade of neglect is so large that we need to think of ways to complement the Fuqua approach. Some of these additional funding modes were discussed at last week's meeting at the Academy. They include both equity and debt financing. This bill is an example of the former. Tax exempt and taxable bonds and notes, government loans, and government-guaranteed bonds are all examples of debt financing. And there are within this taxonomy a great many interesting ideas worth exploring. One example is the establishment of an independent, non-profit corporation, which would be given a start-up trust fund by the federal government. Such a corporation would help academic institutions by providing credit support or leveraging for capital borrowings in the tax-exempt bond market.

The particular ideas are less important than what they imply:

- That the research community is now intensively investigating new financial arrangements for facilities; that is, arrangements to leverage limited federal funds. However, universities need something to leverage, and this bill offers them that.
- That facilities issues pose both short-term and long-term problems, and strategies for both time frames must be explored.
- That the issue cannot simply be dropped upon the federal government, and other sectors, such as states acting individually or through compacts, need to address it.

Let me briefly turn to some concerns with the bill. I do so within the context of supporting its goals. And I do so within the context of what Michael Collins said when he was asked how the National Air and Space Museum was built on time and under budget. His response was that: "The perfect airplane is still in the hangar." The bill may not be the perfect airplane, but I hope it flies.

One concern is with the implicit tithing of agency R&D budgets. I know that the hope is to have facilities funding be an add-on rather than a set-aside. But that sentiment is not expressed in the bill, for fiscal 1988 and beyond. Of course, given the millstone of the federal deficit, any attempt to write in an add-on would almost certainly doom the bill. I do feel that the authorization funds for fiscal year 1987 must be retained as a "trigger" mechanism for allowing the ten percent set-aside in the out years. I also share Chairman's Fuqua's hope that the unhappiness, which many faculty members will have with the ten percent allocation, will be mitigated by an overall growth in the basic research budget of the federal government.

A second concern is that, as I pointed out in Senate testimony earlier this year, the level of unencumbered research funds available to the NSF has declined in the current budget. The reasons are a mix of salutary purposes: To fund the engineering research and supercomputer centers, presidential young investigators, new instrumentation, and the like. Nevertheless, the upshot is a superficial growth in research funding that translates, on closer inspection, into a reduction in core support for basic research. While I have not examined the parallels with other agencies, I suspect that their budgets will exhibit similar trends.

Given that, the Committee might well consider whether each agency might be given some leeway in how it allocates facilities funding out of its R&D budget. Needs tend to be uneven, by field and other elements. Certainly, a ten-percent allocation for facilities funding would help in some areas, but might be potentially damaging in others. The Committee might acknowledge variable pressures on agencies for facilities funding by building greater flexibility in the bill's allocation formula. Perhaps, as was suggested at the meeting last week, an agency, rather than being immediately required to provide ten percent of its R&D funds, might be allowed to move up to that level over a fixed time -- say, three to five years. Also one might consider campus by campus flexibility.

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The bill is welcome and it is overdue. Thank you.

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July 1985

FRANK PRESS

Frank Press was born in Brooklyn, New York in 1924. He received his undergraduate degree in physics from the City College of New York, and advanced degrees in geophysics from Columbia University in 1946 and 1949, when he joined the Columbia faculty, becoming associate professor in 1952, working in the areas of geophysics and oceanography. In 1955 Dr. Press was appointed professor of geophysics at the California Institute of Technology, and two years later became director of its Seismological Laboratory. He was named in 1965 as the head of the then Department of Geology and Geophysics at the Massachusetts Institute of Technology (MIT), which, under his leadership, expanded into planetary sciences, oceanography, interdisciplinary studies, and the joint program with the Woods Hole Oceanographic Institution, and was renamed the Department of Earth and Planetary Sciences. In 1977 he was appointed by President Carter as the President's Science Advisor and Director of the Office of Science and Technology Policy. In January 1981, he returned to MIT where he was appointed Institute Professor, a title MIT reserves for scholars of special distinction. Dr. Press returned to Washington in July 1981 as the 19th President of the National Academy of Sciences, elected by its members to a six-year term.

Dr. Press is recognized internationally for his pioneering contributions in geophysics, oceanography, lunar and planetary sciences, and natural resource exploration, but his primary scientific activities have been in the study of the seafloor, earth's crust and deep interior. Recognizing the importance of long-period surface waves in studying the earth's structure, he developed the theory for these waves and the instrumentation to record them. Today, the analyses of seismic surface waves and free oscillations are among the most powerful techniques for studying the structure and internal properties of the earth. Dr. Press also saw the need to develop techniques for geophysical studies of the moon and planets, using landed observatories. Author of 160 scientific papers, he is also the co-author of the textbook Earth, widely used in courses in both American and foreign universities.

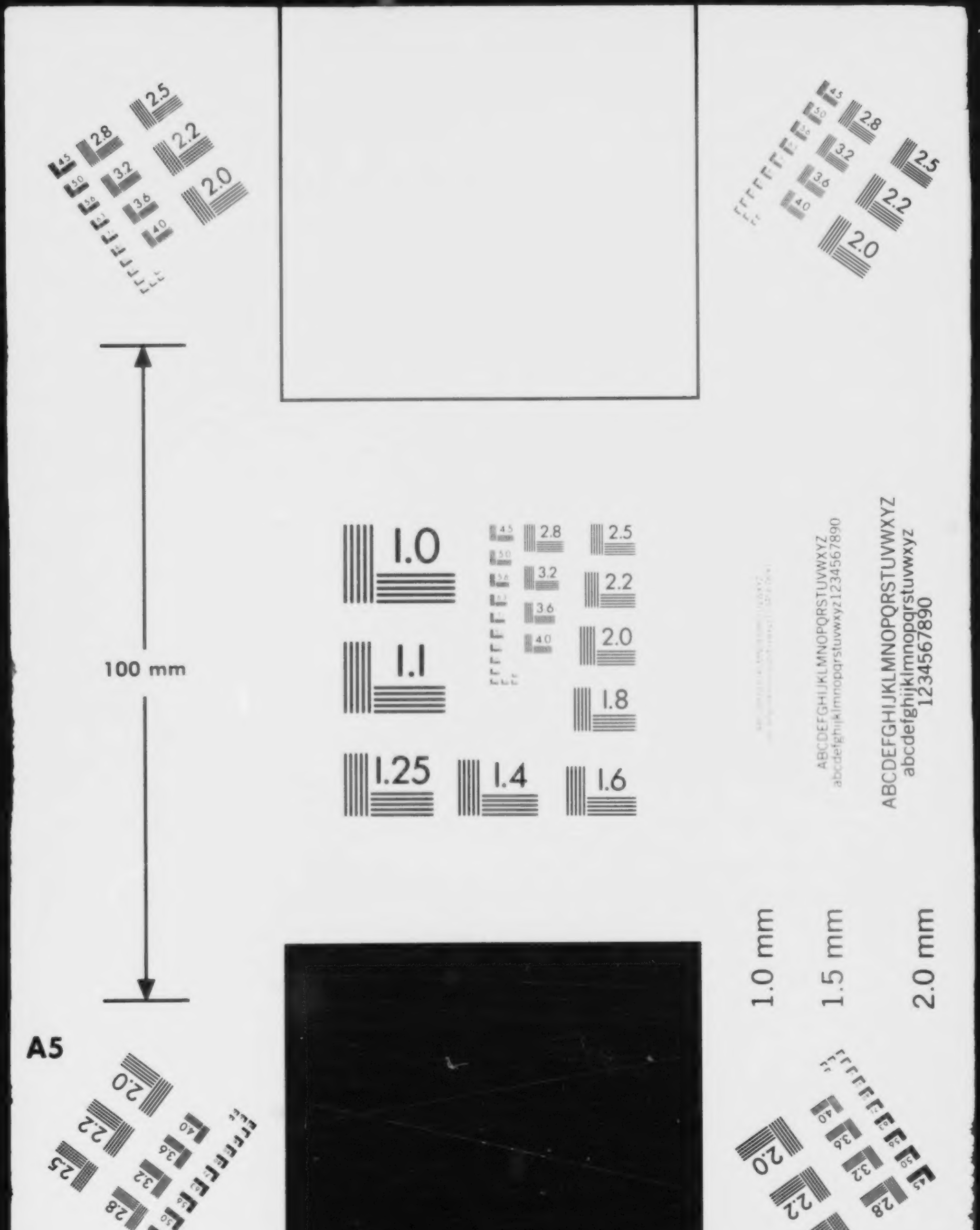
Dr. Press has been a leader in major national and international projects. He helped organize and gave impetus to the International Geophysical Year, the first coordinated worldwide attempt to measure and map various geophysical phenomena, a decade-long effort that involved international explorations of Antarctica and the oceans. Mt. Press in Antarctica is named for him. Dr. Press provided leadership in research efforts on earthquake prediction in the United States, and in international cooperation with Japan, the USSR, and the People's Republic of China.

As NAS President, Dr. Press will continue a long career of public service, in addition to his distinguished scientific work. He served on the President's Science Advisory Committee during the Kennedy Administration and on the Baker and Ramo Presidential Advisory Committee during the Ford Administration. He was appointed by President Nixon to the National Science Board, which is the policy-making body of the National Science Foundation, and he also served on the Lunar and Planetary Missions Board of the National Aeronautics and Space Administration. Dr. Press participated in the bilateral science agreement negotiations with China and the Soviet Union, and was a member of the U.S. delegation to the nuclear test ban negotiations in Geneva and Moscow.

Major initiatives of his Washington service as OSTP Director and Science Advisor during the Carter Administration included increasing the Federal commitment to the support of basic research; the introduction of new measures to spur industrial innovation; joint research ventures involving industry, the university, and the government; and regulatory reform, particularly in improving the scientific basis of proposed regulations. Dr. Press was largely responsible for the U.S.-China scientific cooperation agreements in 1979.

Dr. Press is a member of several professional organizations, and is a former President of both the Seismological Society of America and the American Geophysical Union. He was elected to the National Academy of Sciences in 1958, the American Academy of Arts and Sciences in 1966, and the American Philosophical Society. In 1981 he was elected as a foreign member of the French Academy of Sciences, and to the Board of Trustees of both the Sloan Foundation and Rockefeller University, as well as to the membership of the Corporation of the Massachusetts Institute of Technology. In 1985 he was elected as a foreign member of the Royal Society. He is the recipient of numerous honors, among which are the Gold Medal of the Royal Astronomical Society, the Arthur L. Day Medal of the Geological Society, the Bowie Medal of the American Geophysical Union, ahd in 1982, the Maurice Ewing Medal of the Society of Exploratory Geophysicists. He was awarded the Department of the Interior's Public Service Award in 1971 and NASA's Distinguished Public Service Medal in 1973. In 1982, 1984, and 1985 during annual surveys conducted by U.S. News and World Report, he was named the most influential American scientist. Dr. Press has received 20 honorary doctoral degrees. His unique distinction lies perhaps in the dual contribution of the impact of his scientific work on the development of modern geophysics and the influence of his personal leadership in national science planning and administration.

Dr. Press is married to the former Billie Kallick of St. Louis. The Presses have two children and two grandchildren.



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Mr. **Walgren**. Thank you very much, Dr. Press, for that testimony. Apparently there are sort of short-term and long-term aspects of the academic facilities problem. Are they of such a nature that short term or longer term would be addressed better by this bill? Are there different mechanisms that serve the shorter or the longer term more directly? Can you discuss that area for the record and the committee here?

Dr. **Press**. I think the bill provides a flexibility to handle both. I believe the first-year authorization is very important, very significant to the bill. Without it, as someone said earlier, there would be a loss of support, and also the need to address important short-term issues. There are some very famous productive, successful laboratories where the record of discoveries are the envy of the world, that are essentially in a crisis situation. They can't get the new tools to continue doing this kind of excellent work without some improvement to their facilities. And I think this is the short-term issues that I spoke of.

These are long-term issues which you addressed. Some emerging institutions that want to achieve this high capacity for highly productive research. And they have this longer term need, these longer term goals, and I think the bill addresses these as well.

That's what I had in mind in addressing the short- and long-term goals, and I think the bill does do that.

Mr. **Walgren**. The size of this problem, I guess, has satisfied everybody that it was beyond any immediate resources, and then I get the impression that we haven't stopped counting, or at least we recently, in the last NSF bill, we asked them to actually add up the size of the problem and to do a disciplined study of the amounts involved and how big a problem this is.

Are you satisfied that the problem is substantially larger than the 10-percent allocation in the bill? If we were to invest this much in the system, is it such that we know we should do at least that, or should we be waiting until somebody comes in with a comprehensive study of exactly what the dimension of this problem is? Or are there such studies that should be brought to our record at this point?

Dr. **Press**. I think that's an essential question, a very important one. The comprehensive review has to go forward. We need that review to convince your colleagues in Congress, the executive branch agencies, OMB, that there is an important need.

Every study I have seen, every judgment I have heard from individuals and groups that have sort of surveyed the panorama of facilities, leads me to believe that $5 billion over 10 years, which this bill envisages, is a fraction of the actual need, a small fraction but a significant one. It starts us down the road of recognizing that we need capital outlays to improve the infrastructure if we're going to maintain our scientific strength.

So, reserving final judgment for the kind of evaluation that you have commissioned, I would say that the bill is realistic in setting a minimum need at the present time. It's eminently justifiable from what we know. What the actual needs are must await the comprehensive study.

Mr. **Walgren**. You touch in your testimony on the wish that we had all new money to do this, and the difficulty of set-asides invading current research programs. One of the dilemmas that Dr. Healy developed in her testimony was that although we want to be able to do whatever it is we want to do currently, nonetheless we must set priorities. And that implies that we can't do what we want to do.

Are you comfortable with the feeling that redirection, if it is the only new investment that we can come up with on the Federal level in facilities, is enough of a priority that, as Dr. Healy says, we must set priorities and the choice must be then to invest in this longer term rather than the continuation of the imbalance between the facilities and the operating accounts?

Dr. **PRESS**. I would say that I am basically optimistic. That even though we're in a very difficult position with our deficit, that by and large over the decade—which is the view that this bill examines, that is, the forward looking view that this bill examines—over the next decade, that we will see Congressional support for a growing budget in the areas of science and technology.

And therefore, this reallocation will take place—perhaps not this year or next year, but over a decade, in a period of growth, small growth, but growth nevertheless, so that the facilities can be part of that growing budget without damage to the core support the projects support. That is the heart of our research establishment.

The support that we saw for this bill at the Academy conference last week, I think, also is based on that hope. After all, in recent years, during very tough fiscal times, Congress and the executive branch did give an unusual priority to the support of science.

And with the recognition, the growing recognition in this country, that its future industrial, economic strength, agricultural strength, let alone the national security, lies in our foundation in science and technology. And with that recognition nationally, I believe that my optimism is not unrealistic.

So, to give you an answer succinctly, I feel that the strength of this bill is that there is a basic optimism that the science budgets will grow modestly, but sufficiently, to minimize the impact on project support that the set-aside will require.

And if we had some flexibility in that set-aside, if it weren't a fixed formula but could be analyzed on the basis of agency needs, of discipline needs, but with a commitment for the first time in 20 years to this kind of allocation to infrastructure, if we had all of that, I think we could have a very successful bill.

Mr. **WALGREN**. Is the National Academy playing a particular role in this that you'd like to at least outline at this point? Not in this particular subject of increasing these budgets, but I mean the assessment of the facilities and the developing of the recognition of the problem.

Dr. **PRESS**. I'd like to believe that we're playing our traditional role as an umbrella organization, a friend and ally of the Government, Congress, the executive branch, where we bring the various elements that are concerned with this issue—Members of Congress, their staffs, certainly the university community, the industrial community, the executive branch individuals—together to discuss the problem and to see if we can come up with creative solutions. And that was the purpose of our 2-day conference of a few weeks ago.

This is a key issue in the future of American science and technology, and I think we have to be involved with it in the way that I describe.

Mr. **Walgren**. I'd be curious about the development of this concept of comprehensive merit based review—comprehensive merit evaluation. And you indicated that that's sort of a developing area in contrast to the individual support and the project-by-project based funding where choices are more finite, I gather, and more comparative in some sense. And how this larger view is a more systemic one than one focused just on individual projects.

You indicate that that's sort of what happened to the large facility reviews, the large national facilities, the Fermilabs and the like. Can that be brought down to the small level that Chairman Fuqua was directing his remarks to, the individual facility that is not a national laboratory or a national resource at that point, but just one part of the overall system?

Dr. **Press**. I believe so. And that was actually one of the conclusions of one of the panels that met at the Academy last week. It's only a few sentences and let me read you what they said.

> The allocation process for research facilities is not exclusively the result of a competition among proposals for identical facilities. Rather, the process is the result of an evaluation on a case-by-case basis of the technical merit, local capabilities and aspirations, and other factors that impinge on the ultimate success of each individual facility proposal. Such other factors include social, economic, and political considerations.
>
> For these reasons, the phrase comprehensive merit evaluation best describes the process for review of research facility proposals.

And they are referring to the kind of facilities that Chairman Fuqua envisages in his bill. I believe under these conditions, those places with a proven track record of high productivity in science, of making the major discoveries, will be supported. And those emerging institutions which have evidenced a commitment, a local commitment, in terms of investment and in terms of bringing in first class people will also compete well. And that's what we mean by a comprehensive merit evaluation. To allow for both of those possibilities.

Mr. **Walgren**. There was that group of smaller liberal arts colleges that recently did a survey of their participation in National Science Foundation grants, and found it to be wanting largely, apparently, on the idea that they're not the research centers per se. But they make a valid point that they are both doing perhaps not the quantity of research that is being done at the large research centers, but perhaps something along the same quality of research, inasmuch as they have some of the best teachers and the best—and that those teachers are certainly working at the leading edge of their discipline.

And earlier it was suggested that this bill would be aimed just at research per se. Inasmuch as those colleges are the undergraduate experience of a substantial fraction of those who ultimately are our scientists, would you envision them as participating in this kind of a bill?

Dr. **Press**. I think the bill addresses the Nation's needs in research and graduate education. The research university, which is the primary target of this bill, unlike that of any other country, in the United States the research university is really the basis for our scientific strength. And I think this bill addresses a 20-year shortfall in supporting the research university in building its infrastructure and modernizing it. In recognition of the rapid advances in science, it requires new kinds of facilities.

The need of the small colleges that primarily turn out students who then go into science, but do no research, is a real need. And it has to be addressed some way. But if we try to make this an omnibus bill, that addresses all of these issues, I think it would become so loaded down that its primary goal might be lost.

And so, I don't want to minimize the needs of these small colleges, but I would hope that we address this very difficult problem of our physical plant in the research area, as this bill wants to do, as well as find some way over time of handling the needs of the smaller schools—which are not very large incidentally. They want teaching laboratories, and perhaps over time we can find a way to handle that, once we find a way to get rid of our $200 billion deficit.

I think this is a legitimate area for the Department of Education, for example, to invest in. There is a national concern at all levels of education about the quality of science and mathematics education. And there are many important issues that the Department of Education must address, but I can't think of any more important one than this one.

And so somehow involving that very large department, and perhaps the National Science Foundation, over time we can address the needs of the smaller schools that have quality education programs. But I think that in this bill we have another purpose.

Mr. WALGREN. Are you comfortable in so completely distinguishing between research that's done in a setting where there are graduate students as opposed to research that's done in an undergraduate institution? Now, I realize that their goal is not to do research per se, and their whole thrust has been to emphasize the importance of liberal arts.

But nonetheless, because of our respect in this society for the liberal arts education and it's importance in humanizing the longer run of things, are you really comfortable in saying that the research that goes on not in a graduate student context should not be dealt with, or dealt with on a totally different basis through a totally different department and through programs that are drawn in ways that do not reach this graduate student research focus, admittedly more highly focused, effort?

Dr. PRESS. There are many small schools that have a few faculty members who do quality research, and they apply to the National Science Foundation and they get supported as they should be. They're not discriminated against. If they write good proposals and they have a good record of successful accomplishments, they do get supported.

The larger number of teachers at these smaller liberal arts colleges, science teachers, I believe they need something else. They need a program of periodic enrichment, of periodic association with research groups at nearby universities which have research facilities.

The way I would want to help these teachers is through perhaps fellowship programs, which enable them to work during the summer or take a year off occasionally, and get that research experience that will improve their teaching even more. No matter how great a teacher may be, there is a need to be replenished, renewed and catch up on what's new.

And if you want to help those liberal arts schools, one can help their faculties keep up to date in the ways that I have described. And there must be some other creative mechanisms, not terribly expensive, to keep those schools doing what they do so well, turning out some high caliber, well educated liberal arts students who then seek careers in——

Mr. **Walgren.** Is there much debate about this in the academic community? Do you feel that what you just said is a very, very broad consensus or——

Dr. **Press.** I would guess so.

Mr. **Walgren.** Well, OK. Well, I guess we've covered the ground that we sort of set out for ourselves. We appreciate very much your testimony, Dr. Press, and look forward to seeing you again soon.

Dr. **Press.** Thank you.

Mr. **Walgren.** On behalf of the committee, let me thank all the witnesses for their presentations and participation in this discussion. And we look forward to developing this problem with other hearings in the future.

Thank you.

[Whereupon, the hearing was adjourned at 12:25 p.m.]

H.R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

TUESDAY, OCTOBER 22, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to call, at 1:40 p.m., in room 2325, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Mr. **Walgren**. Let me call us to our agenda this afternoon.

Today, the Subcommittee on Science, Research and Technology continues its hearings on laboratories at U.S. colleges and universities. During these hearings we will hear from representatives from the academic and research communities and from a number of the major Federal research and development agencies.

We have asked the witnesses to provide us with their views on the need for research facilities modernization and for their suggestions for appropriate methods and alternatives to H.R. 2823, the bill that has been introduced in the House of Representatives by the chairman of the full Science and Technology Committee, Mr. Fuqua.

The subcommittee members will recall that in our previous hearing on this subject we received testimony from Mr. Fuqua; from Dr. Bernadine Healy, then Deputy Director of the Office of Science and Technology Policy; and from Dr. Frank Press, President of the National Academy of Sciences. At that hearing we engaged in general discussion of the proper Federal response to the need to modernize academic research facilities. And on that occasion, Chairman Fuqua encouraged us to look broadly in this subject with the goal of achieving some sort of consensus on a Federal program.

There is real interest in that bill and in this subject, and some of us have already had close consultation with constituents that are involved in one way or another offering their views on the legislation. These hearings will give us further opportunities to learn from a variety of parts of the scientific range in our society, both inside and outside the academic community. Certainly this is a question of watershed proportion and one that we believe will be the subject of action by the Congress.

We have received numerous requests from those seeking to present testimony to the subcommittee, and we have tried to accommodate as many as possible. But there are limits to our time in the hearing, and so many we have asked to give us submissions in another form. We do have a number of witnesses today, and in view of the member interest as well, I would like to emphasize to those who will be making presentations to try to limit yourself to something in the range of 5, 5-plus minutes and focus on the points that you believe should be underscored. All of your written testimony will be reproduced in full in the transcript so that as a reference document your submission in writing will be complete regardless of whether you touch on a particular point in our time to discuss.

So with that we look forward to your testimony and want to welcome the first panel. And first, our special welcome to Erich Bloch, who is the Director of the National Science Foundation and familiar to all of us on the committee. We appreciate your being available for these discussions. And joining Mr. Bloch is Col. Donald Carter, U.S. Air Force, Acting Deputy Under Secretary of Defense for Research and Advanced Technology with the Department of Defense. Colonel Carter is accompanied by Dr. Leo Young, who is the Director of Research and Laboratory Operations with the Department of Defense. And we welcome you as well.

Well, with that let me recognize other members for comments and thoughts.

Mr. **Boehlert**. Thank you, Mr. Chairman. Your enthusiasm to move on is shared by all of us, so I will be very brief. I have a statement that I ask permission to have included in its entirety in the record. But I do want to say as a cosponsor of the chairman's bill and a very strong advocate of providing the necessary funding we need for this type of activity, university research facilities, I tell my people in academia that I view this as a jobs bill. And there is nothing more important in my estimation for the future of this country than a greater number of employment opportunities. That is going to solve a lot of our problems, and we can do it in part by providing adequate funding for these university research facilities.

Yesterday, I had the privilege of being in my district on the Cornell campus where I was lobbied very intensively by some very distinguished Americans in support of this bill. And I assured them that this committee on a bipartisan basis would be working very diligently to accelerate the pace, but we don't want to proceed with such dispatch that we neglect to fine tune the legislation. And that is why we are having the hearing here today.

[The prepared opening statement of Mr. Boehlert follows:]

Opening Statement

Honorable Sherwood Boehert, R-NY
Subcommittee on Science, Research and Technology
October 22, 1985

Mr. Chairman, Members of the Subcommittee, ladies and gentlemen, I am pleased to have this opportunity to continue discussion of H.R 2823, the University Research Facilities Revitalization Act of 1985. As the subcommittee's press release states, and as the Chairman's statement describes, we are continuing hearings in an effort to establish a very accurate and complete record on the status, need and appropriate approaches to the funding of university research facilities.

There are several organizations, individuals and points of view to be heard on this topic, and we intend that no one be overlooked. As I understand, there have been a series of events leading to the drafting of H.R. 2823, none less than the fact that this Committee has been in the center of recent debate over the role of peer review and the use of Federal R&D dollars for construction and funding of university proposals that have not necessarily even been subject to the review of Congressional authorization process.

The issue at hand is a very complex one and at the onset, I would like to commend Mr. Fuqua for a willingness to cooperate and consider this bill open for amending.

Mr. WALGREN. Thank you, Mr. Boehlert.

Other thoughts? Mr. Cobey? Mr. Brown? Mr. Valentine? Mr. Bruce?

Well, welcome to the committee, Mr. Bloch. Please proceed.

STATEMENTS OF ERICH BLOCH, DIRECTOR, NATIONAL SCIENCE FOUNDATION, WASHINGTON, DC; COL. DONALD CARTER, USAF, ACTING DEPUTY UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ADVANCED TECHNOLOGY, DEPARTMENT OF DEFENSE, WASHINGTON, DC, ACCOMPANIED BY LEO YOUNG, Ph.D., DIRECTOR OF RESEARCH LABORATORY MANAGEMENT, DEPARTMENT OF DEFENSE, WASHINGTON, DC

Mr. BLOCH. Thank you, Mr. Chairman. And I want to thank you for inviting me to discuss a matter of major importance to the scientific, engineering and technological health of the Nation.

There is no question that research facilities of the Nation's universities are in need of serious attention, and for a number of years we have delayed dealing with this particular problem hoping always that next year would bring a budgetary situation that would make it less painful to deal with this important issue. We have tended to put our priorities elsewhere and with a result that a substantial fraction of existing facilities are obsolete and entirely new facilities are needed in many of the disciplines.

The question of what to do about this subject has been getting some attention of late, and I just want to enumerate a number of these opportunities that we had to discuss the subject. First of all, the National Science Board Committee on Excellence in Science and Engineering addressed the question in considering the need to reinforce the principle of expert peer review. There was a major conference on the subject last July under the auspices of the Government-University-Industry Research Roundtable, cosponsored by the National Science Board that addressed that problem, and I know there are a couple members of this particular committee that attended and participated in that particular meeting—Mr. Fuqua and Mr. MacKay, particularly. The third occasion was the introduction, obviously, of H.R. 2823, the University Research Facilities Revitalization Act of 1985, and that has stimulated further important debate and discussion. In response to that, another committee of the National Science Board, the Committee on Science Policy Review, has taken up the topic and issued a report containing some very important principles of which I will talk in a minute.

The foundation has recently issued an important notice to our universities and other research organizations that amends and clarifies our policy on supporting facilities construction and renovations. We are well into the process of developing the surveys of facilities needs that are called for in the 1986 authorization bill, also as an additional and important kind of an input to this discussion and that we believe are crucial to developing a true picture of the situation.

I make these points and I recount these various items in order to underscore the obvious importance of the issue. This committee deserves much of the credit for all of this activity by essentially focusing us on this vital kind of important problem.

The recent report of the Board's Committee on Science Policy Review set down two very basic principles that we believe should govern efforts to deal with the problem.

The first principle is that universities and colleges that do research work under Federal sponsorship should be able to recover the costs of the facilities through the mechanism of indirect costs. The rate of recovery should be realistic, taking into consideration the reasonable expected life of the facility. And this can be done through use charges or through depreciation schedules on a building-by-building basis. So there are at least a couple mechanisms to address that problem.

Using indirect costs to reimburse the universities, as opposed to separately financing research facilities, has a number of advantages:

One, it bases the reimbursement for facilities costs on the actual costs to the universities as determined by the accounting system.

Second, it allocates facilities support in direct relation to the actual research performed and couples it to the actual research performed.

And it maintains the quality controls which peer review provides by tying facilities support to research projects which are peer reviewed.

So realistic cost recovery is our first order of importance to solve this particular problem.

The second principle is that NSF must consider facilities along with all other needs in deciding how to allocate limited funds. The character of research is changing so as to make it much more dependent on specialized facilities than has been the case in the past. And this is especially true now in such areas as materials research, molecular biology and microelectronics. But I believe strongly that it will be true in many of the disciplines in the future equally.

The important notice that we recently sent to university presidents and which we are submitting as part of this particular record makes the shift in policy clear. The essence of it is that we will balance the needs within a given field, supporting projects, major equipment, and facilities as the needs of each field dictate. The details are important that are in this particular notice and I want to just highlight them.

It makes the point that principal responsibilities for facilities lie with the universities and substantial cost sharing on bricks and mortar is expected. A second point that it makes is that there are compelling cases where we will consider in all areas of research and education the need for facilities in order to do the research. But it also makes the point that our priorities are project support first, major equipment and instrumentation second, and bricks and mortar third. And in that second area of major equipment and instrumentation let me just point out that in our 1986 budget request that item alone is about 20 percent of our total budget, and that has been increasing over the last few years on a very rapid rate. So we have recognized that in the major equipment area and instrumentation area there is a tremendous need for corrective action to essentially further the research capabilities of the universities.

Now, we believe, turning now to H.R. 2823, we believe that the principles outlined above are a sound basis for proceeding, and that they are preferable to the approach contained in this particular bill. In particular, we feel that by allocating a fixed proportion of all R&D resources—10 percent in the bill—is undesirable. We will never have enough money to do all we would like to do, and in the present financial climate, the cost of meeting the objectives of the bill would in all probability be drawn from funds that would otherwise be available for research support and which are already in very scarce demands.

We have to be sure that the available funds are used in the most efficient way possible. And any formula requirements such as the one that is being proposed simply make that much more difficult.

Therefore, while the foundation agrees with the underlying concerns of the bill, and we are supporting that underlying concern and going to take action on the underlying concern, it does not support the bill in its present form, and it is not clear to us that new legislation is necessary. Enforcing the principles and actions that I outlined before, I think will take us a long way toward resolving the causes of the problem that we are all viewing today.

Thank you very much.

[The prepared statement of Mr. Bloch follows:]

National
Science
Foundation

STATEMENT OF
MR. ERICH BLOCH
DIRECTOR, NATIONAL SCIENCE FOUNDATION
BEFORE THE
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES
OCTOBER 22, 1985

TESTIMONY
MR. ERICH BLOCH
DIRECTOR, NATIONAL SCIENCE FOUNDATION
BEFORE THE
SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY

OCTOBER 22, 1985

"THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985"

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE:

IT IS, ONCE AGAIN, A PLEASURE TO APPEAR BEFORE THIS COMMITTEE TO DISCUSS A MATTER OF MAJOR IMPORTANCE TO THE SCIENTIFIC, ENGINEERING, AND TECHNOLOGICAL HEALTH OF THE NATION.

THERE IS NO QUESTION THAT THE RESEARCH FACILITIES OF THE NATION'S UNIVERSITIES ARE IN NEED OF SERIOUS ATTENTION. FOR A NUMBER OF YEARS WE HAVE DELAYED DEALING WITH THIS PROBLEM, HOPING ALWAYS THAT "NEXT YEAR" WOULD BRING A BUDGETARY SITUATION THAT WOULD MAKE LESS PAINFUL THE NECESSARY CHOICES. IN THE UNIVERSITIES THEMSELVES, IN OUR STATE LEGISLATURES, AND IN THE FEDERAL AGENCIES CONCERNED WITH RESEARCH WE HAVE TENDED TO PUT OUR PRIORITIES ELSEWHERE, WITH THE RESULT THAT A SUBSTANTIAL FRACTION OF EXISTING FACILITIES ARE OBSOLESCENT, AND ENTIRELY NEW FACILITIES ARE NEEDED IN SOME OF THE MOST IMPORTANT NEW FIELDS.

THE QUESTION OF WHAT TO DO ABOUT IT HAS BEEN GETTING SOME ATTENTION. THE NATIONAL SCIENCE BOARD COMMITTEE ON EXCELLENCE IN SCIENCE AND ENGINEERING ADDRESSED THE QUESTION IN CONSIDERING THE NEED TO REINFORCE THE PRINCIPLES OF EXPERT PEER REVIEW. THERE WAS A MAJOR CONFERENCE ON THE SUBJECT LAST JULY UNDER THE AUSPICES OF THE GOVERNMENT - UNIVERSITY - INDUSTRY RESEARCH ROUNDTABLE, SPONSORED BY THE NATIONAL SCIENCE BOARD, THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY, AND THE NATIONAL ACADEMIES OF SCIENCE AND OF ENGINEERING. SEVERAL MEMBERS OF THIS COMMITTEE, INCLUDING MR. FUQUA AND MR. MACKAY, PLAYED IMPORTANT ROLES IN THAT CONFERENCE.

MORE RECENTLY THE INTRODUCTION OF H. R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985, HAS STIMULATED FURTHER IMPORTANT DEBATE. IN RESPONSE TO THAT, ANOTHER COMMITTEE OF THE NATIONAL SCIENCE BOARD, THE COMMITTEE ON SCIENCE POLICY REVIEW, HAS TAKEN UP THE TOPIC AND ISSUED A REPORT CONTAINING SOME IMPORTANT PRINCIPLES.

THE FOUNDATION HAS RECENTLY ISSUED AN "IMPORTANT NOTICE" TO OUR UNIVERSITIES AND OTHER RESEARCH ORGANIZATIONS THAT AMENDS AND CLARIFIES OUR POLICY ON SUPPORTING FACILITIES CONSTRUCTION AND RENOVATION. AND WE ARE WELL INTO THE PROCESS OF DEVELOPING THE SURVEYS OF FACILITIES NEEDS THAT ARE CALLED FOR IN THE FY 1986 AUTHORIZATION BILL, AND THAT WE BELIEVE ARE CRUCIAL TO DEVELOPING A TRUE PICTURE OF THE SITUATION.

I RECOUNT THESE VARIOUS ITEMS IN ORDER TO UNDERSCORE THE OBVIOUS IMPORTANCE OF THE ISSUE, AND TO MAKE IT CLEAR THAT A LOT OF SERIOUS THOUGHT IS GOING INTO TRYING TO FIND A SOLUTION.

THIS COMMITTEE DESERVES A LOT OF THE CREDIT FOR ALL THIS ACTIVITY. THROUGH THE HEARINGS OF THE SCIENCE AND TECHNOLOGY TASK FORCE. THROUGH THE INITIATIVE IN MANDATING SURVEYS IN THE AUTHORIZATION BILL, AND ESPECIALLY BY INTRODUCING H. R. 2823, THE COMMITTEE HAS RAISED THE ISSUE TO A MUCH HIGHER LEVEL OF CONSCIOUSNESS. IN SO DOING, IT HAS MADE THE LIKELIHOOD OF A SUCCESSFUL SEARCH FOR A SOLUTION MUCH GREATER.

THE GOVERNING PRINCIPLES:

THE RECENT REPORT OF THE BOARD'S COMMITTEE ON SCIENCE POLICY REVIEW SET DOWN TWO BASIC PRINCIPLES THAT WE BELIEVE SHOULD GOVERN EFFORTS TO DEAL WITH THE PROBLEM.

1. THE FIRST IS THAT UNIVERSITIES AND COLLEGES THAT DO RESEARCH WORK UNDER FEDERAL SPONSORSHIP SHOULD BE ABLE TO RECOVER THE COSTS OF THE FACILITIES USED THOUGH THE MECHANISM OF INDIRECT COSTS. THE RATE OF RECOVERY SHOULD BE REALISTIC, TAKING INTO CONSIDERATION THE REASONABLE EXPECTED LIFE OF THE FACILITY.

USING INDIRECT COSTS TO REIMBURSE THE UNIVERSITIES, AND LEAVING IT TO THEM TO MAKE THE NECESSARY INVESTMENTS, AS OPPOSED TO SEPARATELY FINANCING RESEARCH FACILITIES, HAS A NUMBER OF ADVANTAGES:

- IT BASES THE REIMBURSEMENT FOR FACILITIES COSTS ON THE ACTUAL COSTS OF THE UNIVERSITIES, AS DETERMINED BY THE ACCOUNTING SYSTEM.
- IT ALLOCATES FACILITIES SUPPORT IN DIRECT RELATION TO THE ACTUAL RESEARCH PERFORMED.
- IT MAINTAINS THE QUALITY CONTROLS WHICH PEER REVIEW PROVIDES, BY TYING FACILITIES SUPPORT TO RESEARCH PROJECTS WHICH ARE PEER-REVIEWED.

2. THE SECOND PRINCIPLE IS THAT THE FOUNDATION MUST CONSIDER FACILITIES ALONG WITH ALL OTHER NEEDS IN DECIDING HOW TO ALLOCATE LIMITED FUNDS. IN SOME FIELDS THE CHARACTER OF RESEARCH IS CHANGING SO AS TO MAKE IT MUCH MORE DEPENDENT ON SPECIALIZED FACILITIES THAN HAS BEEN THE CASE IN THE PAST. THIS IS ESPECIALLY TRUE NOW IN MATERIALS RESEARCH, MOLECULAR BIOLOGY, AND MICROELECTRONICS. IN THE FUTURE IT WILL UNDOUBTEDLY BE TRUE IN OTHER FIELDS AS WELL. IN MOST FIELDS THE TRADITIONAL FOUNDATION PRIORITY FOR FUNDING RESEARCH PROJECTS AND MAJOR EQUIPMENT IN PREFERENCE TO FACILITIES CONTINUES TO BE PROPER.

BUT IN THOSE FIELDS IN WHICH A LACK OF SPECIALIZED FACILITIES IS THE CONSTRAINING FACTOR ON RESEARCH WE CLEARLY MUST PLACE A HIGHER PRIORITY ON PROVIDING FACILITIES.

THE IMPORTANT NOTICE THAT WE RECENTLY SENT TO UNIVERSITY PRESIDENTS AND THE HEADS OF OTHER GRANTEE ORGANIZATIONS MAKES THIS SHIFT IN POLICY CLEAR. THE ESSENCE OF IT IS THAT WE WILL USE THE PEER REVIEW SYSTEM TO BALANCE THE NEEDS WITHIN A GIVEN FIELD, SUPPORTING PROJECTS, MAJOR EQUIPMENT, AND FACILITIES AS THE NEEDS OF EACH FIELD DICTATE. ATTACHED TO MY PREPARED STATEMENT IS A COPY OF THIS NOTICE FOR INCLUSION IN THE RECORD.

THE FOUNDATION'S POSITION ON H. R. 2823:

WE BELIEVE THAT THE PRINCIPLES OUTLINED ABOVE ARE A SOUND BASIS FOR PROCEEDING, AND THAT THEY ARE PREFERABLE TO THE APPROACH CONTAINED IN H. R. 2823. IN PARTICULAR, WE FEEL THAT THE RIGIDITY INTRODUCED BY ALLOCATING A FIXED PROPORTION OF ALL R&D RESOURCES -- TEN PERCENT IN THE BILL -- IS UNDESIRABLE. WE WILL NEVER HAVE ENOUGH MONEY TO DO ALL WE WOULD LIKE TO DO, AND IN THE PRESENT FINANCIAL CLIMATE, THE COST OF MEETING THE OBJECTIVES OF THE BILL WOULD PROBABLY BE DRAWN FROM FUNDS THAT WOULD OTHERWISE BE AVAILABLE FOR RESEARCH SUPPORT.

WE HAVE TO BE SURE THAT THE AVAILABLE FUNDS ARE USED IN THE MOST EFFICIENT WAY POSSIBLE. ANY HARD AND FAST REQUIREMENTS SUCH AS THIS ONE SIMPLY MAKE THAT MORE DIFFICULT.

THEREFORE, WHILE THE FOUNDATION AGREES WITH THE UNDERLYING CONCERN OF THE BILL, IT DOES NOT SUPPORT H. R. 2823 IN ITS PRESENT FORM. AT LEAST AT PRESENT, IT IS NOT CLEAR TO US THAT NEW LEGISLATION IS NECESSARY.

MR. CHAIRMAN, THAT CONCLUDES MY PREPARED STATEMENT. I WOULD BE HAPPY TO RESPOND TO ANY QUESTIONS THAT THE COMMITTEE MAY HAVE.

NATIONAL SCIENCE FOUNDATION
Office of the Director
WASHINGTON, D.C. 20550

Notice No. 98 **September 27, 1985**

IMPORTANT NOTICE TO PRESIDENTS OF UNIVERSITIES AND COLLEGES AND HEADS OF OTHER NATIONAL SCIENCE FOUNDATION GRANTEE ORGANIZATIONS

Subject: **Policy on Construction and Renovation of Research and Education Facilities**

The National Science Foundation and the National Science Board have recently considered again the question of providing support for research and education facilities, as opposed to support for major equipment and instrumentation or specific projects. It is the Foundation's policy that principal responsibility for providing facilities for research and education remains with academic institutions. The Foundation will, however, consider limited support for facilities when a compelling case can be made.

Each NSF program must consider competing needs for project support, for major equipment and instrumentation and for facilities in deciding how to allocate limited funds. The criteria for selection are the same in all cases, and are as stated in *Grants for Scientific and Engineering Research* (NSF 83-57, rev. 1/85). Substantial cost sharing will be required in all grants in which facilities are supported.

All NSF programs will consider proposals that include funds for facilities construction, renovation, or improvement in competition with all other proposals received. The Foundation's current budget is constrained, and no new or special funds are expected to be available for facilities. In most fields, the Foundation will continue to give first consideration to project support, then to major equipment and instrumentation, and then to facilities. However, in fields in which research is especially dependent on specialized facilities, and a compelling argument is made that facilities are required to achieve specific research or education objectives, facilities support will be provided.

Interested parties are advised to contact the Foundation before submitting a proposal.

Erich Bloch
Director

Mr. **Walgren**. Thank you very much, Mr. Bloch.

Let's turn directly to Colonel Carter then, and then we'll return to both of you as a panel and we'll have discussion.

Colonel Carter.

Colonel **Carter**. Thank you, Mr. Chairman, members of the committee. I am pleased to be invited to appear before this committee today to represent the Department of Defense in addressing the modernization of college and university research facilities.

With me today is Dr. Leo Young, as you noted earlier. He is the Director of our Research and Laboratory Management Office within the Office of the Secretariat.

I would like to describe the work which we have done to assess the need for facilities improvement and current DOD programs aimed at upgrading laboratories. I would then like to offer some observations and recommendations with respect to the pending University Research Facilities Revitalization Act of 1985.

The Nation's defense, as well as its economic health, is dependent upon our ability to maintain a strong scientific and technological capability. The major advances in weapons systems which have allowed us to keep a technological advantage over the Soviets are based on the discoveries and developments from our past research investments. Therefore, it's important that we conduct a strong and vigorous science and technology program now to ensure the Nation's future security.

Our universities play a uniquely important role relative to the strength of the science and technology base. They are the principal performers of the basic research which generates the scientific insight and knowledge which form the basis for future technological information.

University research activities also provide an essential environment for the development of future scientists and engineers. Universities are a major factor in the defense science and technology activities. About one-half of all DOD basic research funds are expended on university campuses; that is, about $430 million for fiscal year 1985, plus a small fraction of our exploratory development funds which amount to about $120 million in 1985.

The prime purpose of these programs is to create new knowledge and develop new technology to provide future defense options.

Now, we recognize that the principal funding mechanism, the individual investigator research grant or contract, does not usually provide the resources necessary to address the capital intensive components of an effective research laboratory such as the major research instrumentation and facilities. Consequently, we have programs underway which will provide additional funds for instrumentation. In order to determine the technological area-specific needs for support to research laboratories, we conducted a survey to, one, document the research laboratory needs of universities engaged in DOD research; second, to assess the needs by academic field; third, provide estimates of costs to meet those needs; and, four, provide specific recommendations. In April of this year, the results of that survey were provided to the Subcommittee on Research and Development of the House Committee on Armed Services.

In order to reduce the study to manageable proportions, we focused the survey on five disciplines critical to DOD: Chemistry, physics, electronics, engineering, materials. The most pressing needs were found to be in the areas of electronics, materials, and engineering where the recent rapid advances in technology are straining university resources to keep pace. Requirements for facilities and equipment in physics and chemistry were substantial, but notably less, and the major need in physics was facilities to support the development of directed-energy devices. Chemistry needs were lowest, reflecting a proportionately lesser DOD involvement in the broad aspects of experimental chemistry.

I would like to now discuss our current DOD program for academic laboratory modernization. Our direct funding of universities not only provides the research to meet our technology base needs, but also provides a major resource for educational and instrumentation support. In 1985, this direct support was about $500 million. For each $1 million of university research, we support about 10 to 15 graduate students and we purchase about $100,000 of research instrumentation. With each $350,000 to $400,000 of research funding we have supported a new Ph.D. These supplemental benefits derived from the DOD research program make a major contribution to ensuring the strength of the Nation's science and engineering capability.

Now, we provide for the reimbursement of indirect costs through depreciation or use allowance which is included as an indirect expense to provide partial payment for the use of university facilities. On the average, this allowance contributes 4.5 percent to the 45-percent indirect cost rate. In 1985, this mechanism provided the universities with over $15 million from DOD contracts.

In addition to the research program, we are making a major effort to improve the research capabilities of the Nation's universities through two major initiatives. One of these is the University Research Instrumentation Program which was initiated in 1983 to provide funding to purchase some of the more expensive research equipment items required to modernize university laboratories. This program is a 5-year, $150 million effort to provide items of equipment in the $50,000 to $500,000 price range which can be used in research of primary concern to the services. The program was funded at $30 million per year, or is funded at $30 million per year through fiscal year 1987. In our first 3 years we awarded $90 million, and the awards for the next increment of $60 million will be for fiscal years 1986 and 1987. Those awards will be announced in the spring of 1986 pending the outcome of evaluations of proposals that are due in this November.

In 1986, we will initiate a new DOD-university research initiative—this fiscal year. And this initiative will address concerns about the infrastructure of science and technology in the United States and its relation to a stronger national defense. Twenty-five million dollars has been included in our budget for this new start. We made it through the first two committees, the Armed Services Committees, and the Conference Committee for the Armed Services increased it to $100 million; and we are busily working it in the Appropriations Committees.

The first thrust includes fellowships, scholarships, exchange scientists and instrumentation programs, and we will involve our in-house laboratories and our scientific research offices with the objective of enhancing the Nation's science and engineering capability and, at the same time, strengthening the interaction between the in-house laboratories and the Nation's universities.

The second thrust of this new initiative will be the initiation of multidisciplinary science and engineering research programs in a number of high risk, potentially high payoff areas such as materials, fluid mechanics, aeronautics, computer sciences, and microelectronics.

The proposed legislation, would establish a program for funding the replacement and modernization of research facilities at colleges and universities. Congress would authorize funding for the first year. In subsequent years the act provides for a reserve to be funded out of the total agency research and development awards to universities and colleges. It is our interpretation that such a program would lead to a substantial loss of funds from our research program as such, as well as loss to our support for research instrumentation and education of scientists and engineers at universities.

Now, in summary, we agree that there is a great need to upgrade and modernize the academic research facilities and instrumentation, and collectively we must seek a means to provide the state of the art research laboratories that this Nation needs. Universities are a valuable part of our science and technology program. We look to them to provide the majority of our research and to educate the scientists and engineers which are in increasing demand by both the DOD and universities—and industry—excuse me.

DOD has made a major commitment to upgrade the university instrumentation and to support graduate and postgraduate education in science and engineering. The problems of rapid obsolescence and rising costs of modern research instrumentation are being partially met through our University Research Instrumentation Program and our university research initiative.

Our programs emphasize those elements of the university research structure that are most dependent on DOD funding: Principal investigators, students, and equipment. Universities are generally more successful in finding support for the other elements, especially facilities, from State governments, private industry, and other sources. We view this as an appropriate, healthy division of a funding burden which would be overwhelming to any one sector.

Now, there is a clear and urgent need to provide modern facilities for university researchers, and means for funding these need to be found which do not jeopardize our current research effort. We are eager to work with this committee, with the universities, the State governments, and the private sector to find suitable mechanisms to modernize university laboratories.

Thank you again for the opportunity to appear before your committee.

[The prepared statement of Colonel Carter follows:]

HOLD UNTIL RELEASED
BY THE SUBCOMMITTEE

THE DEPARTMENT OF DEFENSE STATEMENT ON THE MODERNIZATION OF COLLEGE AND UNIVERSITY RESEARCH FACILITIES

By

COLONEL DONALD I. CARTER, USAF
ACTING DEPUTY UNDER SECRETARY OF DEFENSE
FOR RESEARCH AND ADVANCED TECHNOLOGY

BEFORE THE SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY OF
THE COMMITTEE ON SCIENCE AND TECHNOLOGY OF
THE UNITED STATES HOUSE OF REPRESENTATIVES
99th CONGRESS, FIRST SESSION

22 OCTOBER 1985

Mr. Chairman and members of the Committee:

INTRODUCTION

I am pleased to be invited to testify before this Committee and to represent the Department of Defense in addressing the modernization of college and university research facilities.

Today I will describe the work which we have done to assess the need for facilities improvement, the recommendations which resulted from those assessments, and current DoD programs aimed at upgrading laboratories. I would then like to offer some observations and recommendations with respect to the pending University Research Facilities Revitalization Act of 1985.

The nation's defense, as well as its economic health, is dependent upon our ability to maintain a strong scientific and technological capability. The major advances in weapons systems which have allowed us to keep a technological advantage over the Soviets are based on the developments and discoveries from our past research investments.

Technology, however, is a perishable commodity. Our task is to sustain progress in order to have the technical options available to provide the technologically superior weapons of the future. However, there is a long lead time from an idea to military hardware. Therefore, it is important that we conduct a strong and vigorous science and technology program to ensure the future well being of the nation's security.

Our universities play a uniquely important role relative to the strength of the science and technology base. They are the principal performers of the basic research which underpins our technological advances. Hence, they are vital to maintaining the country's military and economic strength. In addition to generating the scientific insight and knowledge which form the basis of future technological innovation, university research activities provide an essential environment for the development of future scientists and engineers. DoD was among the first Federal agencies to recognize the essential role that the academic community plays in the continuance of U.S. technological leadership.

Universities are a major factor in the DoD science and technology activities. Approximately half of all DoD research funds are expended on university campuses (approximately $430 million in FY 1985), plus a small fraction of exploratory development funds (approximately $120 million in FY 1985). The prime purpose of these programs is to create new knowledge and develop new technology to provide future defense options.

University research has been a major component of growth in the DoD technology base during the past decade. During the period FY 1975 to FY 1985, DoD spending for research at universities grew at a real annual rate of seven percent -considerably greater than the growth of Defense research funds as a whole.

It is recognized that the principal funding mechanism - the individual investigator research grant or contract -does not usually provide the resources necessary to address the capital-intensive components of an effective research laboratory, such as major research instrumentation and facilities. In acknowledgement of this difficulty, the DoD took action to provide additional funds for instrumentation - through the University Research Instrumentation Program and the University Research Initiative discussed below - and to determine the extent of the needs for laboratory and facilities upgrade.

The DoD-University Forum Working Group on Engineering and Science Education in its report of July 1983, addressed the issue of research laboratories in the context of its examination of the nation's diminished capability to produce well-qualified engineers and scientists. In addition to stengthening human resources programs such as fellowships, exchange scientists, and young investigators, the study recommended that additional funds be provided for instrumentation and that (emphasis in report)

> "The new initiatives recommended below should be funded with new appropriations and not at the expense of the sustained real growth required in the research programs."
>
> "A university research facilities rehabilitation program should be established. DoD should undertake a research laboratory rehabilitation program targeted on fields of interest to Defense, and encourage other agencies to begin similar programs, each in furtherance of their particular interests and missions."

In order to determine the area-specific needs for support of research laboratories, the DoD conducted a survey to (1) document the laboratory needs of universities engaged in DoD research, (2) assess the priorities by academic field, (3) provide estimates of costs to meet those needs, and (4) provide specific recommendations. In April of this year, the results of that survey were provided to the Subcommittee on Research and Development of the House Committee on Armed Services in the report titled "Selected University Laboratory Needs in Support of National Security."

The survey focused on five disciplines determined to be critical to DoD. These are chemistry, electronics, engineering, materials and physics. It was recognized that these do not cover the breadth of the DoD research interests but that other major areas, e.g., biomedical and biological sciences and computer resources have been or would be covered in data collection efforts of other agencies (NIH, NSF, and DoE).

In order to get a more complete picture of the requirements, the survey addressed the needs for both the facilities and major equipment which are essential to a modern laboratory. The survey was conducted through the Service Research Offices (ARO, ONR, and AFOSR) and the Defense Research Projects Agency (DARPA). The result was an estimate of the university laboratory upgrade and modernization initiatives necessary to bring the laboratories closer to sufficiency from the DoD perspective.

The most pressing needs were found to be in the areas of electronics, materials, and engineering where the recent rapid advances in technology are straining university resources to keep pace. Requirements for facilities and equipment in physics and chemistry were substantial but notably less. The major need in physics was facilities to support the development of directed energy devices. Chemistry needs were lowest, reflecting a proportionately lesser DoD involvement in broad aspects of experimental chemistry.

CURRENT DOD PROGRAMS/RESOURCES FOR ACADEMIC LABORATORY MODERNIZATION

The direct funding of universities by DoD not only provides the research necessary to meet our technology base requirements but also provide a major resource for educational and instrumentation support. In FY 1985, this direct support was over $500 million. For each $1 million of university research, we support 10 to 15 graduate students and purchase $100 thousand of research instrumentation. With each $350-450 thousand of research funding we have supported a new Ph.D. These supplemental benefits derived from the DoD research program make a major contribution to ensuring the strength of the nation's science and engineering capability.

In addition to the research program, the DoD is making a major effort to improve the research capabilities of the nation's universities through two major initiatives, the University Research Instrumentation Program and the University Research Initiative. These programs are supplemented by the funds provided to universities through indirect (overhead) charges to DoD research contracts.

University Research Instrumentation

In 1983 the DoD initiated a new program to provide funding dedicated to the purchase of some of the more expensive S&T equipment items required to modernize university laboratories.

The University Research Instrumentation Program is a five-year, $150 million program to provide items of equipment in the $50,000 to $500,000 price range which can be used in research of primary concern to the Services. The program is funded at $30 million per year through FY 1987, and approximately equals the annual funding level for equipment items which are routinely included in research contracts with universities. In our first three years, we awarded $80 million in over 650 grants to 152 universities in 47 states. Awards for the next increment of $60 million for FY 1986 and FY 1987 will be announced next spring as the result of the evaluation of proposals due in by November 1985.

DoD-University Research Initiative

In FY 1986, we plan to initiate a new DoD-University Research Initiative. This program will address some of the widespread concerns about the infrastructure of science and technology in the United States and its relations to a stronger national defense and national economy. Twenty-five million dollars has been included in the Research program, approximately $6 million for each of the three Services and DARPA. We plan to grow this program in the near term. This new start will consist of two major thrusts.

The first thrust includes fellowship, assistantship, exchange scientist and instrumentation programs. The first three, "people programs," will involve our in-house laboratories and scientific research offices with the objective of enhancing the nation's science and engineering capability and, at the same time, strengthening the interaction between in-house laboratory and university researchers. Additional funding for instrumentation has been included in this initiative.

The second thrust of this new initiative will be the initiation of multidisciplinary science and engineering research programs in a number of high risk, potentially high payoff areas such as materials and structures, fluid mechanics, aeronautics, biotechnology, communication networks, computer science, microelectronics, and optical materials. The intent is to support programs which concentrate talent to achieve the "critical mass" required to accelerate research achievements. These multidisciplinary programs will be managed through a Tri-Service and DARPA committee which will provide close coordination with DoD and a single point of focus for the universities.

Indirect Reimbursement

Indirect costs allowable on DoD contracts are determined following the Office of Management and Budget guidance. Responsibility for approval and audit of the indirect rate for any one university is assigned either to the Department of Health and Human Services or the Office of Naval Research as the cognizant agency. A depreciation or use allowance is included as an indirect expense to provide partial payment for the use of university facilities in the accomplishment of the research program. On the average, this allowance contributes 4.5 percent to the 45 percent indirect cost rate. In FY 1985, this mechanism provided the universities with over $15 million from DoD contracts.

UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

The proposed legislation (HR 2823) would establish a program for funding the replacement and modernization of research facilities at colleges and universities. Congress would authorize and appropriate funding for the first year. In subsequent years, the bill provides for a reserve to be funded out of the total agency research and development awards to universities and colleges. It is our interpretation that such a reserve would lead to a diversion of funds from the support of education of scientists and engineers as well as from research and development at universities. We estimate that if the formula proposed for calculating the reserve were applied only to our research funding, the result would be a substantial loss in our ability to adequately support science and engineering programs at universities.

SUMMARY

Our experience and recent studies support the conclusion that there is a need to upgrade and modernize academic research facilities and instrumentation. In order to strengthen the nation's capability to perform the innovative research which is necessary for technologically superior defense systems, we must seek the means to provide state-of-the-art research laboratories. This must be done while maintaining the significant real growth in the DoD research program which is necessary to ensure our long-term technological superiority.

As a mission agency, DoD sees the universities as a valuable part of our science and technology program. We look to them to perform the majority of our research and to educate the scientists and engineers which are in increasing demand by both DoD and industry. Our university research program also serves to attract the new faculty, support the graduate students, and provide the modern instrumentation which are all essential to a strong research posture.

In addition to the direct funding of university research, DoD has made a major commitment to upgrading university instrumentation and to supporting graduate and post-graduate education in science and engineering. The problems of rapid obsolescence and rising costs of modern research instrumentation are being partially met through our University Research Instrumentation Program and University Research Initiative. The URI will also expand on-going programs to provide graduate and post-graduate education in critical areas of science and technology. In emphasizing support for human resources and instrumentation, we are making major contributions toward improving the overall quality of university research in the nation.

In providing funding for university research, DoD is supporting those elements of the university research structure which are most dependent upon DoD funding: principal investigators, students, and equipment. In our experiences universities have been quite successful in finding support for other elements, especially facilities, from state governments, private industry, and other sponsors. We view this as an appropriate, healthy division of a funding burden which would be overwhelming to any one sector.

There is a clear and urgent need to provide modern facilities for university researchers. Means for funding these requirements need to be found which do not jeopardize the current research effort. We are eager to work with this Committee, with the universities, the state governments and the private sector to find suitable mechanisms to modernize university laboratories.

Mr. Walgren. We appreciate that very much, Colonel.

Do you have any written statement, Mr. Young?

Mr. Young. No, I have nothing to add at this time. Thank you.

Mr. Walgren. Well, thank you both for those presentations.

Let me ask, Mr. Bloch, presently is there a substantial amount of NSF funds that goes toward bricks and mortar?

Mr. Bloch. No. The answer is no, there is not a great amount. For instance, in 1985 it was about $16 million, which is a small portion, obviously, of the $1.5 billion that the Foundation is spending. But let me just point out that the bill is not only restricting itself to bricks and mortar the way I read the bill. It talks about fixed equipment—fixed installation, fixed equipment, and major equipment, also. And that's why I focused before on what the Foundation is doing in that other area called instrumentation, as well as fixed equipment and major equipment. And we're doing quite a bit in that, as I tried to demonstrate with——

Mr. Walgren. You mentioned something like 20 percent or something like that?

Mr. Bloch. Yes. In 1986, on our budget request for 1986 it would be $270 million, which is about 20 percent of the total. In 1985, it was $245 million, which is about 16 percent of the total. And that includes major equipment such as ships and telescopes and super computers, plus also the smaller kind of instrumentation and equipment that you find in the individual laboratories.

Mr. Walgren. But then as you read the bill, and we reach that point where there is a requirement that you look at your overall budget and calculate 10 percent of that and invest that in these more long-lasting facilities, as you read the bill, you are already doing that.

Mr. Bloch. Well, if the bill really—and that's why I was careful in the way I stated it before. If the 10 percent includes major equipment, I'm saying we're doing that already, that's correct. If the 10 percent really only means brick and mortar in the literal sense of the word, then we're way under, and then I have the same concern that Colonel Carter expressed. That now you are eating into the research base, or now you are eating into the funding that is available for the research base, and that's why we took the position that I outlined a minute ago.

And that doesn't mean, by the way, and I want to make this very, very, very, very clear. We are addressing, we are now addressing the facilities problem even within the research base as it exists today by putting this important notice out, which essentially tells the universities that they can come in to the Foundation if they have facility requirements that will allow them to perform the particular research for which they are applying. Then they can come into the Foundation and we will take that into consideration. And that's a—I'll say that's a deviation from the way we have been operating and it's putting more focus on the bricks and mortar aspects of it than we have been doing in the past.

But we would like to do it within the overall total that the Foundation has available for its support of research.

Mr. Walgren. Let me ask the same question, then, of Colonel Carter. That as you calculate your numbers and your present investment in—well, I guess not all indirect costs go to support facilities, do they?

I'm wondering what is your present investment in the kinds of facilities that would qualify or that this bill is aimed at driving.

Colonel **Carter.** Insofar as bricks and mortar, our current investment is very, very low. Probably almost to zero, quite frankly, in bricks and mortar. Now, in instrumentation that could conceivably be considered as part of the bill, then we are fairly heavily invested. For example, as I noted, roughly for each $1 million of funding that we provide to universities, a substantial portion of that is for instrumentation associated with doing the particular research. But again that's for spectrophotometers or computer support, for glassware, and that sort of thing.

In addition, the indirect costs that I mentioned, which is about 4.5 percent or so of each contract in overhead, also goes to the university, and the university uses that for whatever they would like to. However, that is such a small amount that it really wouldn't fund any brick and mortar facilities.

We do have a few in-house laboratory construction programs in which to build or refurbish an in-house laboratory on occasion, and some of those would be such things as a wind tunnel or a ship test bed or something of that nature. And indeed, university researchers are invited to participate with us in using those facilities, those are fairly unique and often fairly expensive——

Mr. **Walgren.** What percentage are the indirect costs of your overall research effort?

Colonel **Carter.** In the research program itself that goes to the universities, about 45 percent is the indirect overhead costs. And of that 45 percent, only about 10 percent or so goes to this particular aspect.

Mr. **Walgren.** Goes to?

Colonel **Carter.** To the facilities aspect.

Mr. **Walgren.** But indirect costs that in fact could be traced to investments in these kinds of facilities should qualify, I would gather——

Colonel **Carter** Yes, sir.

Mr. **Walgren** [continuing]. Under the bill. Can you estimate what percentage of your indirect costs other than the 4.5 percent, or is that the——

Colonel **Carter.** That's it.

Mr. **Walgren.** That's the designated number.

Colonel **Carter.** The rest of it is overhead for lights and water, and guard service and that sort of G&A.

Mr. **Walgren.** Why don't I turn to my colleague?

Mr. **Boehlert.** Well, I guess we don't have any problems, or many problems that money can't solve.

Mr. Bloch, you talked about the survey of facilities needs. When do you expect that will be completed?

Mr. **Bloch.** Well, first of all, Congress asked that it be concluded in September of 1986 and that's what we're gearing up to. Let me—let me just make a point on that. Obviously that requires a very rapid and very—and I'll say a very cursory kind of a survey. We hope that over time for the next—for next—we're asked to repeat that every 2 years. That for the next cycle we have a much more intensive and more thought through kind of a survey.

So we will definitely have answers back by—by the date that you have set, September 1986. We are doing it essentially by preparing for that survey right now. They're being mailed out, early 1986. We're also going to augment it by some of the surveys that are going on right now, or that are being planned right now; namely, the NIH survey of facilities which is planned for late 1985 or early 1986. And we will take that into consideration when we come back to you and give you the results of it.

Mr. BOEHLERT. When we're talking about facilities needs, you're going beyond just bricks and mortar; you're—big equipment?

Mr. BLOCH. Yes. Yes, but——

Mr. BOEHLERT. But we want——

Mr. BLOCH. But it's very important, as the previous discussion has pointed out, that we try to separate these numbers from each other. Because bricks and mortars is a little bit different than fixed equipment or major equipment or even instrumentation. So we got to get to the point now where we can stratify that and differentiate between one category and the other because they are entirely different in their nature. They should be—in my opinion they are different in their priorities or in priorities they deserve. So the sooner we can separate the various parameters from each other the better off we will be.

Mr. BOEHLERT. What kind of reaction have you gotten to your September 27 "Important Notice"?

Mr. BLOCH. It's too early to say.

Mr. BOEHLERT. Really?

Mr. BLOCH. I think so, yes. Let me tell you——

Mr. BOEHLERT. I'm surprised their phones won't ring——

Mr. BLOCH. No, the phone isn't ringing. My phone isn't ringing off the hook. Maybe somebody's phone is. I hope so.

Mr. BOEHLERT. Pay your bill last month?

Mr. BLOCH. Right. But I think in general it has been received very well, number one. It's being looked at as a new approach by the National Science Foundation. And by the way, in all candor, I should underline that we not only put this one out to put the community on notice that we are serving, but put our own people on notice. Our program officers are on notice that this is a different way of operating from how they've been operating before.

Mr. BOEHLERT. Um hum.

Mr. BLOCH. So the effect internally is probably as important as the effect externally to us. But I think out of that one again, out of the responses over time there will be a good indicator of what the universities think the real problem in facilities is. So I think this is another input to that survey.

Mr. BOEHLERT. Colonel Carter, you mentioned in page 2 and 3 of your testimony a survey that you have already conducted, but there were no details provided. Do you have the details that you can provide the subcommittee?

Colonel CARTER. Yes, we have——

Mr. BOEHLERT. How many responded and what, in essence, did they tell you?

Colonel **Carter**. We, in essence, did not do it as a survey—a questionnaire sort of thing, we did it as our survey of talking to individuals from universities, and I will be pleased to make a copy of them for the bill—the record.

[The material referred to follows:]

THE DEPARTMENT OF DEFENSE
REPORT ON

SELECTED UNIVERSITY LABORATORY NEEDS IN SUPPORT OF NATIONAL SECURITY

PREPARED FOR THE SUBCOMMITTEE ON
RESEARCH AND DEVELOPMENT OF
THE COMMITTEE ON ARMED SERVICES OF
THE UNITED STATES
HOUSE OF REPRESENTATIVES

29 APRIL 1985

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CHAPTER I

INTRODUCTION

A. RATIONALE

The Report of the House Armed Services Committee on the 1984 Department of Defense Authorization Act contained the following request: "Many of the university laboratories in which Department of Defense research programs are conducted are obsolete and in need of major modernization or replacement. The committee believes a study should be undertaken on the need to modernize university laboratories in the physical sciences, earth and ocean sciences, atmospheric sciences, engineering, computer sciences and other fields essential to our long-term national security. The survey should (1) document the laboratory needs of universities presently engaged in Department of Defense competitive research programs, (2) assess priorities by academic field, (3) provide estimates of costs to meet these needs, (4) provide specific recommendations appropriate to the Department of Defense and others designed to address the need, (5) state the consequences to our long-term national security."
This report is a response to that request.

The science and technology (S&T) base has, as its cornerstone, basic research which, in the U.S., tends to be concentrated at universities. Approximately two-thirds of basic research in science and engineering (S&E) is carried out in academia. There is a concomitant integration of basic research with graduate education. The nation reaps a double benefit from this model in that it concurrently generates both research results and future researchers. It is for this reason that the state of U. S. university laboratory facilities is so important to the nation's long-range economic and military competitiveness.

The evolution of science and technology tends to create a requirement for more sophisticated research facilities. Failure to keep pace with facilities' needs has a negative impact on researchers' creativity. This in turn limits the scope of scientific endeavor in the experimental disciplines. The consequences may include delays in the realization of new discoveries and a trend for faculty and graduate students to opt for theoretical studies rather than engage in experimental research with inadequate facilities. A further consequence is the difficulty of recruiting and retaining the most productive faculty in experimental disciplines.

The foregoing points work against university researchers undertaking experimental investigations. When researchers do so in spite of inadequate facilities, results of their endeavors can be compromised in a variety of ways. These include:

- Inadequate environmental control resulting in decreased quality of data
- Excessive down-time resulting in diminished productivity

- Outmoded equipment leading to imprecision in acquired data
- Crowded laboratory space resulting in diminished access to equipment for data gathering and maintenance purposes
- Contrived experimental set-ups representing safety hazards

B. DEFINITIONS

The following definitions will be used throughout this report:

Laboratory Needs-Facilities and equipment which collectively constitute vehicles for the generation of experimental data and other information. It denotes more than a stand-alone instrument (e.g., spectrometer, tensile tester, etc.) that can be operated in general laboratory space typically found on a university campus, but excludes general purpose laboratory buildings. Examples include wind tunnels, high voltage accelerator labs, clean rooms, wave tanks, etc., especially those housed within existing older buildings. It may also include specially designed structures required to house laboratory instrumentation and experimental facilities.

Facilities-Laboratory structural environment including hardware required to maintain special conditions in laboratory space.

Equipment-Instrumentation and devices directly supportive of data acquisition and analysis.

C. RESEARCH DISCIPLINES AND THRUST AREAS

Selected research laboratory needs among universities active in Department of Defense (DOD) competitive research programs are addressed in this report for the following five disciplines and constituent thrust areas:

CHEMISTRY
- Laser Chemistry
- Polymeric Materials

ELECTRONICS
- Microelectronic Fabrication and Reliability
- System Robustness and Survivability

ENGINEERING
- Combustion
- Composite Structures
- Energetic Materials
- Fluid Mechanics and Acoustics
- Manufacturing, Design, and Reliability
- Soil Mechanics

MATERIALS
- Optical and Magnetic Materials
- Silicon and Compound Semiconductor Growth
- Structural Ceramics
- Structural Composites

PHYSICS
- Astrophysics
- Coherent Radiation Sources
- Directed Energy Devices
- Optical Communications and Spectroscopy

The foregoing disciplines do not represent the breadth of DOD research. In particular, biological and biomedical sciences are not included in anticipation of a comprehensive survey of laboratory needs by the National Institutes of Health. Computer resources not dedicated to experimental research facilities are also excluded on the basis that they are the object of considerable study and/or aggressive enhancement programs by the National Science Foundation and the Department of Energy.

D. INFORMATION ACQUISITION

Requisite information was initially assembled by research administrators in the three Service research offices (OXRs): the Office of Naval Research (ONR), Army Research Office (ARO), and the Air Force Office of Scientific Research (AFOSR) and in the Defense Advanced Research Projects Agency (DARPA). In particular, Division Directors in each organization representing the foregoing five research disciplines supplied data related to the sufficiency of research laboratory facilities. This information was analyzed for the purpose of developing laboratory needs representative of defense research priorities. Results are presented in Chapter IV in the form of prioritized laboratory needs (where they exist), estimated costs of desired enhancements, and assessments of the scientific/technological and national security implications of any laboratory needs identified.

Within the framework of the foregoing information acquisition plan, each of the three OXRs identified key R&D performers for the various research disciplines. These performers were then analyzed with reference to the indicated questions. Criteria used in determining the performers to be interrogated and/or analyzed for inclusion in the report involved level of basic (6.1) competitive research funding, evaluations by OXR research administrators, and, as appropriate, independent evaluations of graduate programs corresponding to the various disciplines. In many cases, the stated costs represent partial funding reflecting the tendency of universities to seek multiple sponsors for major laboratory improvements. While the method of data collection does not embody the statistical integrity of a rigorously implemented survey instrument, it is nonetheless thought to be suggestive of the dimensions of university laboratory needs of greatest importance to DOD. Further, the study differs from previous ones in that the cited laboratory needs reflect, in part, the judgment of research sponsors (DOD scientific officers) rather than exclusively the perceptions of research performers.

The primary DOD research performers encompassed by this report are, of course, only a subset of the total university R&D community. The extent to which their modernization and new facilities needs may be extrapolated to all universities performing research for DOD, or to the entire population of approximately 300 research universities in the U.S., is an open issue. Such extrapolations beg the question, however, as to appropriate means for assessing laboratory sufficiency from the DOD perspective. This is a complex question that is under constant scrutiny for each discipline and its constituent research areas. More generally, it is an issue which demands continued vigilance at the national level. Sustained deficiencies in any discipline/thrust area will inevitably cause the corresponding sector of the U.S. science and technology base to erode, thus blunting our competitive position in the national security and world economic arenas.

CHAPTER II
DOD SUPPORT FOR UNIVERSITY LABORATORIES

A. INTRODUCTION

This chapter deals with the role that universities play in sustaining and strengthening the U.S. science and technology base (Section A), the origins of DOD support of university laboratories in that role (Section B), DOD programs that support university science laboratories (Section C.1), and further steps that DOD has taken to upgrade these facilities (Section C.2). A new university research initiative for FY 86 (Section C.3) and coordination activities relevant to the upgrading of university research facilities are described (Section C.4).

Given the importance of university science laboratories to DOD, it is also true that maintaining adequate university research facilities is a national priority that has important economic as well as military significance. Thus, DOD should not and cannot solve the problem alone. Solutions must encompass all relevant government agencies, private industry, and, of course, the universities themselves. This chapter focuses, however, on the relationship between DOD and the university community.

American universities play an indispensable role in maintaining and strengthening the nation's science and technology base. Not only are universities the source of future scientists and engineers, but the research contributions of academia to society are vast as well. Since World War II, universities have performed most of the basic research that has produced the technological innovations on which much of our economy and national defense are based today. Universities contribute nearly three-quarters of the scholarly papers published in the most noted science and technology journals. In addition to generating the insight and knowledge upon which future technological innovation is based, university research provides the environment for the development of future scientists and engineers. The result is enrichment of the professional experience of faculty and graduate students involved in training our nation's technical manpower. Thus, support of university research produces multiple benefits of enormous value to society as a whole.

This report addresses selected needs of university laboratories involved in DOD sponsored research. As much as $2 billion has been estimated as the total sum needed to replace obsolete university research instrumentation. Laboratory facilities, including the instrumentation required to conduct research aimed at modernizing and expanding the U.S. technology base, are becoming increasingly expensive. Establishing and maintaining such facilities are very costly, especially those requiring advanced supercomputers, large particle accelerators, various types of analytical instrumentation, imaging devices, and automated design and manufacturing hardware. Nonetheless, such equipment is crucial for the conduct of research in important areas of science and engineering, and for educating students. DOD support for university research equipment is described in the following sections.

B. ORIGINS OF DOD SUPPORT FOR UNIVERSITY LABORATORIES

The DOD has recognized that technological superiority is essential to military superiority, and it has played an important role in maintaining the strength of the U.S. science and technology base. Since DOD was among the first federal agencies to recognize the essential role that the academic community plays in the maintenance of U.S. technological leadership, it has maintained a strong relationship with U.S. universities since before World War II.

Very little involvement of universities with military technology occurred during World War I, despite the existence of in-house Service laboratories since the 1890s and the earlier creation of the National Academy of Sciences, which was established as a war measure by President Lincoln in 1863. The sudden expansion of experimental and laboratory operations that characterized the outbreak of World War II greatly overburdened the Service laboratories. Many civilian scientists and engineers were added to the staffs of Aberdeen Proving Grounds, the Naval Research Laboratory, the Naval Ordinance Laboratory, Taylor Model Basin, Wright Field (Army Air Force), and Fort Monmouth (Signal Corps). Contracting funds were also greatly increased in the effort to catch up to an enemy that had scientific groups investigating improved weaponry since the early 1920s.

The Office of Scientific Research and Development (OSRD) was created, reporting directly to President Roosevelt, and receiving funds by direct appropriation from the Congress. These funds were placed in private and governmental laboratories. The National Research Council of the National Academy of Sciences had been created during World War I and was, by the time of World War II, well known to the military Services, which expanded their use of it. These arrangements formed a close coupling of the organized bodies of scientists and military leaders having a common appreciation of the importance of science and engineering to modern warfare. Major wartime expansion of facilities occurred at several universities. The major contributors included MIT, Harvard, Columbia, the University of Chicago, the University of California, the Johns Hopkins University, and the California Institute of Technology. Radar, acoustics, operations research, navigation, and atomic weapons were just a few of the areas in which notable contributions were made.

Emerging from the wartime era were two lasting methodologies for defense investment in university laboratory facilities. First, the institute concept became well established, wherein non-profit university affiliated laboratories conduct applied research, primarily under DOD support. Products of this era which make major contributions today are Lincoln Laboratories (MIT), the Johns Hopkins University Applied Physics Laboratory, the Applied Physics Laboratory of the University of Washington, the Applied Research Laboratories of the University of Texas, the Applied Research Laboratory of Pennsylvania State University, and the Marine Physical Laboratory, Scripps Institute of Oceanography, University of California, San Diego. Second, the National Security Act of 1947, and the amendment of 1948 which established the three military Departments and the Office of the Secretary of Defense, provided the framework that operates today for support of research at universities through the Army Research Office, the Office of Naval Research, the Air Force Office of

Scientific Research, and the Defense Advanced Research Projects Agency. This partnership has been substantial over the years; seventeen institutions of higher education are among the 595 contractors that received awards of 10 million dollars or more from DOD in FY 83.

C. PRESENT DOD SUPPORT FOR UNIVERSITY LABORATORIES

C.1 DIRECT FUNDING OF UNIVERSITY RESEARCH

U.S. universities are a major factor in current DOD activities affecting the U.S. technology base. Approximately half of all DOD basic research (6.1) funds are expended at universities ($405 million in contract dollars with research budgets totaling $840 million in FY 84), plus a smaller amount of applied research (6.2) funds (approximately $115 million in FY 84). During the past decade, DOD has made a major effort to reverse the effects of the relative neglect of university research that occurred during the Vietnam war. Figure II-1 shows the evolution of DOD funding for basic research (6.1) since 1962. The corresponding funding history for "exploratory development" (6.2), some of which equates to applied research, is shown in Figure II-2.

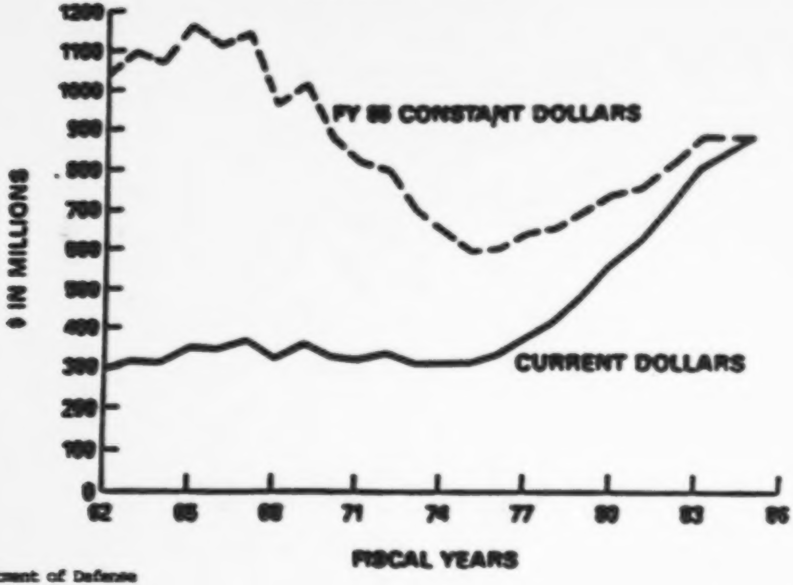
These figures show that funding in current dollars for both components of the technology base grew significantly during the late 1970s and early 1980s; nevertheless, neither has returned to 1965 levels of support in constant dollars. In fact, in real terms, the level of funding for exploratory development has been virtually stable for over a decade. In a memorandum to the Services dated August 9, 1984, Secretary Weinberger noted this situation and indicated that the Defense Guidance for the FY 1987-91 POM would request 8 percent annual real growth in both components of the technology base. DOD still takes that position.

University research has been a major component of the growth in DOD technology base activities during the past decade. Table II-1 shows DOD Basic Research (6.1) funds spent (or projected to be spent) at universities by the Army, Navy, Air Force, and the Defense Advanced Research Projects Agency (DARPA) for the years FY 74-86. During the period FY 75 to FY 84, DOD spending for 6.1 Basic Research at universities grew at a real annual rate of 9 percent—far higher than the annual growth of DOD Research (6.1) funds as a whole.

Table II-1 shows only the DOD Basic Research (6.1) funds going to universities. It includes only contracts exceeding $25,000, and does not reflect research grants. Thus total university funding is somewhat higher than indicated. A similar break-out of the university component of DOD Exploratory Development (6.2) funds is not available. To provide a basis for comparing 6.1 and 6.2 expenditures, in FY 83 a total of $102.3 million in DOD Exploratory Development (6.2) contracts went to universities while $360 million was provided for Research (6.1) contracts. An additional $50 million was awarded to universities in the form of 6.1 research grants. DOD funding for universities is not limited to Research and Exploratory Development. For example, DOD RDT&E (6.1 through 6.6) contracts over $25,000 going to educational institutions in FY 83 totaled $1113.6 million. Most of the $600 million in the higher categories (6.3, 6.4, 6.5, and 6.6) was for R&D in university affiliated off-campus laboratories and Federally Funded Research and Development Centers (FFRDCs), or for vocational and technical training, and tuition fees.

DOD SCIENCE AND TECHNOLOGY FUNDING TRENDS

CURRENT AND CONSTANT DOLLARS
RESEARCH (6.1)



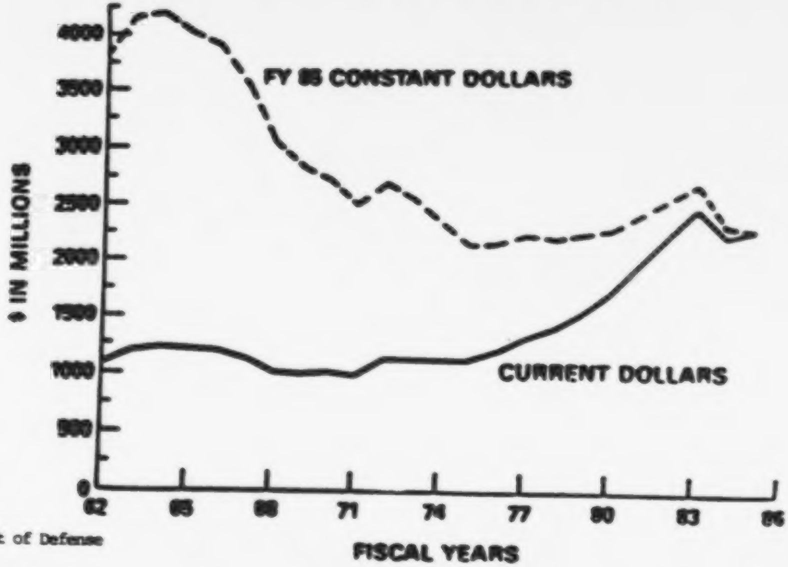
SOURCE: Department of Defense

FIGURE II-1

DOD SCIENCE AND TECHNOLOGY FUNDING TRENDS

FIGURE II-2

CURRENT AND CONSTANT DOLLARS EXPLORATORY DEVELOPMENT (6.2)



SOURCE: Department of Defense

TABLE II-1

DEPARTMENT OF DEFENSE FUNDING FOR UNIVERSITY BASIC (6.1) CONTRACT RESEARCH, FISCAL YEARS 1974-85⁺

(In millions of dollars)

Service	FY 74 Current	FY 74 Real	FY 75 Current	FY 75 Real	FY 76 Current	FY 76 Real	FY 77 Current	FY 77 Real	FY 78 Current	FY 78 Real	FY 79 Current	FY 79 Real	FY 80 Current	FY 80 Real
ARMY	13.7	27.9	13.4	25.0	19.0	33.7	23.7	39.6	28.1	43.8	32.0	49.9	39.1	[illegible]
AIR FORCE	23.2	47.3	22.9	42.6	28.2	50.0	41.0	68.6	49.5	77.1	46.4	66.5	55.3	[illegible]
NAVY	45.5	92.7	47.0	89.2	64.2	113.8	62.7	104.8	70.8	110.3	86.4	120.0	99.2	[illegible]
DARPA	21.9	44.6	19.4	36.1	19.1	33.9	18.7	31.3	17.9	27.9	21.0	30.1	19.8	[illegible]
TOTAL	104.3	212.4	103.6	192.9	130.5	231.4	146.1	244.3	166.3	259.0	185.8	266.5	213.4	[illegible]

Service	FY 81 Current	FY 81 Real	FY 82 Current	FY 82 Real	FY 83 Current	FY 83 Real	FY 84 Current	FY 84 Real	FY 85* Current	FY 85* Real**	FY 86* Current	FY 86* Real**
ARMY	46.5	55.9	56.1	63.5	71.4	77.7	80.6	84.6	83.8	83.8	87.9	83.8
AIR FORCE	63.4	76.2	71.5	81.0	90.3	98.3	112.1	117.6	119.1	119.1	135.0	129.7
NAVY	115.0	130.2	142.3	161.2	152.2	165.6	158.1	165.9	176.1	176.1	190.8	189.5
DARPA	27.3	37.8	39.4	44.6	48.4	50.5	53.9	58.6	42.7	42.7	43.4	41.4
TOTAL	252.2	303.1	309.3	350.3	360.3	392.1	404.7	426.7	421.7+	421.7	459.1	437.7

---

* Projections

** Forecast for inflation is based on CBO projection

SOURCE: Army Deputy Chief of Staff Research Development and Acquisition, Office of Naval Research, Air Force Office of Scientific Research, Defense Advanced Research Projects Agency. (Constant 1985 Dollars Calculated using GNP Implicit Price Deflator)

⁺Restricted to awards exceeding $25,000; grants are not included

DOD sponsors research and development at universities to ensure the progress in fundamental knowledge that is necessary, in the long run, to maintain U.S. technological superiority. The resulting university research programs also serve to benefit universities in a variety of ways. By providing opportunities to perform basic research at the forefront of science and engineering, research programs at universities help to create an environment that can attract and retain faculty and students. Past studies suggest that, on average, $1 million of funding for research provides full or partial financial support for 10-15 graduate students. Using this measure, DOD provided financial assistance for over 4000 graduate students through its university research programs in FY 84. In addition, as will be noted below, DOD-related research programs also have significant effects on laboratory instrumentation.

C.2 INSTRUMENTATION PROGRAM

Instrumentation is essential to modern research. Modern instruments with qualitatively superior capabilities for analysis and measurement often open new fields of scientific inquiry. In some scientific areas, access to the most advanced scientific instrumentation determines in large measure the extent to which scientists can work at the cutting edge of their field.

The Department of Defense, in concert with the scientific and university community, state and other federal agencies, and the Congress, perceived that the condition of research instrumentation in U.S. universities declined significantly during the 1970s. The Association of American Universities (AAU), in a report to the National Science Foundation (NSF) in June 1980 (see Chapter III), concluded that the equipment being used in the top ranked universities has a median age twice that of the instrumentation available to leading industrial research laboratories, an additional factor in the attraction of potential faculty to industry.

The instrumentation problem has been growing for more than a decade. It reflects both economic factors and funding patterns:

- The cost of equipment has risen much faster than inflation.
- The system of one to three year contracts in the $50,000 to $100,000 per year range with individual investigators is not conducive to obtaining equipment that costs more than $50,000.
- Rapid technological advances are rendering research equipment obsolete at an ever increasing rate.

In response to the foregoing situation, DOD has encouraged researchers to include more of their equipment needs in proposals and emphasized that DOD does not set arbitrary limits on the amount of money that may be requested for instrumentation. This approach has been helpful for equipment needs in the $50,000 range or less. However, new money was clearly needed for some of the more expensive items required to modernize university laboratories. These funds were provided in FY 83 through the DOD-University Research Instrumentation Program (URIP), which received Congressional approbation.

URIP provides $150 million over five years for university research equipment. Each of the three Services is programmed to spend $10 million per year. So far, $90 million has been spent on 652 awards going to 152 institutions in 47 states and Washington, D.C., Guam, and Puerto Rico. While URIP is having a major impact on the equipment needs of researchers doing work of interest to DOD, it cannot solve the whole university instrumentation problem. In the first year of URIP, DOD received 2,500 proposals representing requests for $646 million worth of equipment. While some of these requests were for equipment to support research in areas not usually funded by DOD, this response is a significant and impressive measure of the needs of the universities.

URIP is the most visible, but not the sole, DOD response to the university instrumentation problem. As noted previously, each of the Services and DARPA have encouraged current and prospective contractors to make their equipment needs known, in order that many of the less expensive items could be purchased as an integral part of research program funding:

- Approximately 10 percent of Army, Navy, and Air Force research contract funding is applied to equipment purchases, most of it well under $50,000. Grants under the URIP program provide an additional comparable dollar amount for equipment costing more than $50,000.
- The portion of the Army Research Office (ARO) contract program devoted to instrument purchases has increased steadily over the past decade; in FY 85, such purchases will represent about $6 million of the ARO contract research program.
- University-related equipment purchases associated with the Contract Research Program of the Office of Naval Research (ONR) increased from $11.2 million in 1979 to $16.6 million in 1984.
- Between 1975 and 1985, vested equipment funding by the Air Force Office of Scientific Research (AFOSR), during the usual course of its sponsored research program, increased from $2 million to $8 million.
- Although DARPA does not participate in the URIP program, 10 to 20 percent of its university program funds have been utilized for equipment. In 1981, DARPA began a modernization program focused on obsolete equipment and the need for greater computational power. From 1981 to 1984, equipment purchases by universities using DARPA funds increased from $6.7 million to $16.8 million.

In certain cases where the equipment for major research efforts has been especially costly, provisions have been made for extraordinary purchases. Examples include the purchase of large main frame computers, semiconductor processing lines, molecular beam epitaxy and analysis chambers, and ARPANET computational and communication facilities by DARPA, and an ongoing ONR program to refurbish selected research vessels.

In FY 84, in addition to the $30 million per year of special URIP purchases, the three Services and DARPA purchased over $45 million worth of research instruments and equipment for universities in connection with their research contracting activities.

C.3 UNIVERSITY RESEARCH INITIATIVE

In FY 86, DOD plans to establish new research program elements that will be focused exclusively on the DOD/university relationship. Total proposed funding for the new program elements is $25 million in FY 86 and $50 million in FY 87. Significant additional growth is expected after FY 87. Each of the Services and DARPA will implement programs within these program elements to meet the priorities of their own relationships with the academic community. Although the specific proportions will vary from Service to Service, graduate fellowships, support for young investigators, purchase of research instrumentation, support of special research programs, and programs to improve the interactions between DOD laboratory and university researchers, will be part of the total DOD package.

C.4 COORDINATION ACTIVITIES

DOD has long recognized that the academic community is an invaluable source of expert advice. The Department draws on science and engineering faculty as individual consultants and as members of DOD advisory committees. To insure more effective communication with the academic community, DOD established the DOD/University Forum in December 1983. During its first year, the Forum has provided a mechanism for dialogue between DOD and the academic community on policy and other issues of mutual interest. One significant outcome of its activities during the past year was the establishment of a new DOD policy on the transfer of scientific information. It establishes an appropriate balance between the conflicting imperatives of national security and open scientific communications. The Forum Working Group on Science and Engineering Education addressed many issues, including that of research instrumentation.

CHAPTER III

PREVIOUS STUDIES

More than a dozen studies of university laboratory facilities have been prepared since the late 1960s. For a comprehensive listing and summary of such studies prepared by Linda S. Wilson of the University of Illinois at Urbana-Champaign, see the Appendix. Many of these studies have concluded that a problem exists with respect to inadequate and deteriorating university laboratory research facilities. Some of the studies are qualitative and generally recommend programs for the support of facilities renewal. Others are quantitative and are based on surveys of the conditions of facilities, with projections of the amount and cost of construction and renovation required to meet future needs. The basic conclusion drawn is that renewal and replacement of facilities are an important element in assuring a national technology base. Some of the more relevant studies for the purposes of this report are discussed below. An analysis of some of their findings in comparison to the present study is given in Chapter V.

-- A report to the National Science Foundation (NSF) by the Association of American Universities (AAU) in June, 1980, was devoted to "The Scientific Instrumentation Needs of Research Universities." Numerical data for the study were gathered from 14 universities and four commercial laboratories. The report found that the median age of university equipment was twice that of the commercial laboratories' instrumentation. Concluding that "the quality of research instrumentation in major university laboratories" has seriously eroded, the AAU report recommended that:

> "Federal policy for the support of research instrumentation should provide for a basic three-part funding strategy:
>
> - Strengthen instrumentation funding in the project system.
> - Expand special instrumentation programs.
> - Create in the National Science Foundation a new, supplemental formula grant program to provide needed flexibility to meet diverse institutional needs."

-- A 1981 study prepared for the Committee on Science and Research of the AAU, entitled "The Nation's Deteriorating University Research Facilities," was based on a survey of recent expenditures and projected needs of fifteen major U.S. universities in six disciplines. The principal findings of the study were:

- A substantial backlog of research facilities and equipment needs was accumulating.
- During the 1978-81 period, for the six fields surveyed, the fifteen universities spent $400 million for facilities and major equipment. In the next three years (1982-84),

these universities expected to spend almost twice as much ($765 million), just to produce the necessary research facilities and special research equipment for current faculty only.

- o New construction to replace outmoded facilities accounted for almost 60 percent of total projected funding requirements across all fields.
- o In addition, substantial needs for major research equipment were identified in all six fields.

Table III-1 shows the expenditures and projected needs for those disciplines included in the present report. Projected needs for both facilities and equipment were far larger (by factors ranging from three to almost ten) than actual expenditures for an equivalent period immediately preceding the report. The extent to which these differences represented realistic assessments of the pent-up facilities demand, and/or an effort on the part of survey respondents to "make a statement," is open to question.

Among the recommendations of the AAU study was:

- o Provided that a review by key government agencies corroborated the assessment of the survey, the "Department of Defense, Department of Energy, the National Aeronautics and Space Administration, the Department of Health and Human Services, and the Department of Agriculture should establish research instrumentation and facilities rehabilitation programs targeted on the fields of science and engineering of primary significance to their missions."

-- In 1982, Flad & Associates, a Wisconsin architectural and planning firm, published their "Capital Spending Study of Research and Development Laboratories." Since the study focused exclusively on the spending plans of private industrial firms, it provides a useful basis for comparison with the plans of universities dealt with in the AAU studies described above.

The Flad study was based on a survey of some 5800 directors of industrial research laboratories. About twelve percent of them responded with detailed, confidential estimates of planned spending for plant and equipment in the ensuing three years (1983-85). The firms surveyed were considered more representative of large research laboratories (25-100 staff) than smaller laboratories (less than 25).

Among the major findings of the Flad study were:

- o Estimated spending on research and development plant for 1983-85 by responding firms was $1.4 billion.
- o Estimated spending on research and development equipment for 1983-85 was $1.2 billion.
- o Nearly 40 percent of the laboratories of responding firms were built less than ten years before the survey; of these, 50 percent had undergone additions or renovations subsequent to initial construction.

Table III-1

Actual and Projected Expenditures for Research Facilities
(new construction/renovation) and Special Research Equipment
for 15 Major Research Universities
(thousands of dollars)

	FACILITIES			SPECIAL RESEARCH EQUIPMENT		
			PROJECTED NEEDS			PROJECTED NEEDS
FIELD	1978-80	1981	1982-84	1978-80	1981	1982-84
Chemical Sciences	13,875	14,089	115,022	6,701	4,767	14,688
Engineering	19,539	18,476	183,106	16,101	10,957	33,222
Physics	11,700	5,818	74,725	4,603	1,092	22,590

Source: "The Nation's Deteriorating University Research Facilities", Association of American Universities, 1981

For the purposes of this report, the Flad study has some interesting implications. If the study's findings are extrapolated onto the entire sample, total national private industry projected capital spending for research and development would be about $20 billion for 1983-85 (about $11 billion for plant and about $9.2 billion for equipment). This compares with estimates of $1 billion for total average annual planned investments in university science and education facilities. For industrial laboratories whose annual research and development budgets were in the range of 1 to 15 million dollars (45 percent of the responding firms), the expenditure planned for was about 13 percent of their annual operating budget each year for the three years beginning in 1983. The ratio of planned expenditures for equipment and plant by private industry was about the same (unity) as that shown for universities in Chapter IV below.

-- The NSF published a study of "Academic Research Equipment in the Physical and Computer Sciences and Engineering" in December 1984. This study surveyed 43 universities; respondents exhibited serious concern about the adequacy of their current stock of research equipment. Among the findings of the study were:

  o About half of the department heads in physical and computer sciences and engineering characterized research instrumentation available to untenured and tenured faculty as "insufficient."

  o 90 percent of the department heads surveyed reported that, as a result of lack of needed equipment, their research personnel could not conduct critical experiments in important subject areas.

  o The top priority need was to upgrade and expand research equipment in the $10,000 to $1,000,000 range.

  o The estimated original purchase cost of the entire 1982 stock of all $10,000 to $1,000,000 academic research equipment that had been accumulated in the fields surveyed was about $1 billion.

  o Only 16 percent of those systems were classified as state-of-the-art. Of the equipment that was not in the state-of-the-art category, over half was in less than excellent condition; about half of such equipment was the most advanced to which researchers had access.

In addition to the studies and data surveyed above, the NSF has released a variety of data that are of special interest for this report. Table III-2 gives seven-year trend data on capital expenditures at all U.S. universities for both research and instructional purposes. Unfortunately, there does not appear to be any systematic way of extracting purely research facility expenditures from these figures. The two research categories cited correspond roughly to the five disciplines addressed in this report.

TABLE III-2

Research and Instructional Capital Expenditures at Colleges and Universities*

(thousands of dollars)

FIELD	1976	1977	1979	1980	1981	1982	1983
Engineering	81,678	87,718	87,128	89,297	103,329	144,990	134,701
Physical Sciences	73,755	65,216	64,685	77,154	87,813	82,362	87,073
Total:	155,433	152,934	151,813	166,451	191,142	227,352	221,774

Source: National Science Foundation

* 1978 Data not available.

Research equipment expenditures for U.S. colleges and universities are summarized in Table III-3 for 1982 and 1983. The data were obtained from 85 percent of U.S. universities in response to an NSF questionnaire concerning non-capitalized equipment expenditures. Engineering equipment purchases averaged approximately $70 million for the two year period. The category compares roughly to the combined engineering, electronics, and materials categories of this report.

Table III-4 lists 1982 estimated research equipment expenditures for 157 of the largest research universities. These 157 institutions collectively accounted for 95 percent of all nonmedical, non-FFRDC R&D expenditures reported to NSF for FY 1980 by all U.S. colleges and universities. Thus, although the survey represented only a small fraction of the nation's approximately 3,000 post-secondary institutions, it encompassed most institutions with significant capabilities for the kinds of advanced research that require instrumentation in the $10,000+ range. The quoted figures are somewhat higher than those in Table III-3, since they include capitalized equipment, whereas the data of Table III-3 do not. As in Table III-3, the engineering category compares roughly to the combined engineering, electronics, and materials categories of this report.

Acquisition and replacement costs as of 1982 for research quipment in the physical sciences and engineering are given in Table II-5. The total replacement value in 1982 dollars for both fields ceeded $1 billion. It is interesting to note that equipment intenance in both the physical sciences and engineering represented ercent of replacement costs.

TABLE III-3

Annual Expenditures for Research Equipment at Colleges and Universities (thousands of dollars)

FIELD	1982	1983
Engineering	65,861	75,171
Aero/Astro	2,284	2,837
Chemical	6,442	6,172
Civil	5,164	6,086
Electrical	18,454	20,685
Mechanical	7,390	10,008
Other	26,127	29,383
Chemistry	33,323	32,826
Physics and Astronomy	38,316	39,916
Totals:	111,373	118,530

Source: National Science Foundation

TABLE III-4

Instrumentation-related expenditures in academic departments and facilities, by field and type of university: National estimates, FY 1982[1]

[Dollars in millions]

Principal field of research in department/facility and type of university	FY 1982 expenditures			
	Total	Purchase of research equipment[2]	Purchase of research-related computer services[3]	Maintenance/repair of research equipment[4]
Total, selected fields	$375.6	$231.0	$84.7	$60.0
Field of research				
Physical sciences, total	156.6	94.5	33.9	28.2
Chemistry	73.7	39.6	23.3	10.8
Physics and astronomy	83.7	55.2	10.9	17.6
Engineering, total	154.4	90.9	43.9	19.6
Electrical	52.9	36.2	11.5	5.2
Mechanical	23.0	8.7	10.8	3.5
Metallurgical/materials	9.4	7.4	0.8	1.2
Chemical	15.8	7.8	5.7	2.3
Civil	16.4	9.6	5.4	1.4
Other, n.e.c.	36.7	21.3	9.5	5.9

[1] Statistical estimates encompass all research departments and all nondepartmental research facilities in the physical sciences, engineering and computer science at the 157 largest R&D universities in the U.S., except: (a) departments with no research instrument systems costing $10,000 or more and (b) research installations consisting of interrelated components costing over $1 million (large observatories, reactors, accelerators, etc.). Sample size = 353 departments facilities. The columns below do not add up to the indicated totals because computer science and interdisciplinary have been omitted from this abbreviated version of the original table.

[2] Estimates refer to expenditures for nonexpendable, tangible property or software having a useful life of more than two years and an acquisition cost of $500 or more, used wholly or in part for scientific research.

[3] Estimates refer to purchase of computer services at on-campus and off-campus facilities but not to purchase of computer hardware or software.

[4] Estimates encompass expenditures for service contracts, field service, salaries of maintenance/repair personnel, and other direct costs of supplies, equipment and facilities for servicing of research instruments.

Source: "Academic Research Equipment in the Physical and Computer Sciences and Engineering"; National Science Foundation, December, 1984.

TABLE III-5

Number and aggregate cost/value of academic research instrument systems in active research use, by field and type of university: National estimates, 1982.[1]

[Dollars in millions]

Principal field of research use and type of university	Number of systems	Index of aggregate cost/value			
		Purchase cost[2]	Acquisition cost[3]	Replacement value[4]	1982 cost-equivalent[5]
Total, selected fields	17,586	$758.1	$703.2	$1,133.7	$1,162.8
Field of research					
Physical sciences, total	8,424	373.6	353.2	529.3	610.2
Chemistry	4,791	210.4	201.1	295.0	331.7
Physics and astronomy	3,633	163.2	152.1	234.3	278.4
Engineering, total	6,829	259.4	232.4	413.3	374.6
Electrical	1,650	66.4	56.0	92.2	89.0
Mechanical	1,363	50.9	47.8	95.5	66.9
Metallurgical/materials	998	39.0	36.6	65.2	60.9
Chemical	682	23.3	22.8	28.6	32.3
Civil	397	14.1	13.9	22.4	21.6
Other, n.e.c.	1,739	65.7	55.3	109.0	104.0

[1] Statistical estimates refer to research instrument systems (including all dedicated accessories and components) originally costing $10,000-$1,000,000 in physical science, engineering, and computer science departments and facilities at the 157 largest R&D colleges and universities in the U.S. Estimates limited to systems used for research in 1982. Sample size = 2,582 systems. The columns below do not add up to the indicated total because computer science, materials science, and interdisciplinary have been omitted from this abbreviated version of the original table.

[2] Manufacturer's list price at time of original purchase.

[3] Actual cost to acquire instrument system at this university, including transportation and construction/labor costs.

[4] User estimate of 1982 cost of same or functionally equivalent equipment.

[5] Original purchase cost converted to 1982 dollars using Machinery and Equipment Index of the Bureau of Labor Statistics' Annual Producer Price Index to adjust for inflation.

Source: "Academic Research Equipment in the Physical and Computer Sciences and Engineering"; National Science Foundation, December, 1984.

CHAPTER IV

SELECTIVE UNIVERSITY LABORATORY MODERNIZATION

A. INTRODUCTION

This chapter addresses selected laboratory needs, i.e. facilities and related equipment, for a segment of the research university community representing key performers of DOD research for the disciplines and thrust areas enumerated in Chapter I. These needs, stratified by discipline and priority in Table IV-1, reflect the judgment of university research performers and, in certain cases, of administrators in the Service research offices (OXRs) and the Defense Advanced Research Projects Agency (DARPA). It should be emphasized that the cost figures in Table IV-1 are estimates of university laboratory upgrade and modernization initiatives designed to bring university laboratories closer to sufficiency from the DOD perspective. As previously indicated, they represent in many cases only partial funding of the facilities in question through multiple sponsor arrangements. They are not intended to encompass laboratory needs of the entire university research community. The latter issue has been addressed in the various studies cited in Chapter III. Facilities costs vary among and within disciplines, reflecting special requirements for the various thrust areas. They encompass both floor space requirements and laboratory accessories not falling within the instrumentation category. Thus, not all expenditures classified as "facilities" represent requirements for new or renovated buildings. The stated new floor space requirements are expressed in "gross" (as opposed to "net") square feet at $120/ft^2$. Laboratory renovation costs are calculated at $90/ft^2$.

The allocation of laboratory needs among the five disciplines required the exercise of judgment as to the appropriate division between (a) the parent, pure science fields of Physics and Chemistry, and (b) the applications-focused areas of Electronics, Engineering, and Materials. Ultimately, such decisions are to an extent arbitrary. Further, there are clearly a great number of ways to stratify facilities and equipment needs in terms of disciplines and thrust areas. The scheme presented in this report is thus only one of many possible approaches.

Priority 1 facilities needs for the five subject disciplines, pro-rated over a five-year expenditure period, are $32 million per year. The expenditure level is equivalent to the URIP annual allocation of $30 million. It is also of interest to note that priority 1 equipment requirements are $31 million per year, i.e., almost identical to the annual expenditure rate of the five-year $150 million URIP initiative. Unquestionably, some portion of the $155 million Priority 1 equipment needs cited in this report will be addressed during the final two years ($60 million) of the URIP program.

Table IV-1. Summary of selected laboratory needs of major university performers of defense research.

Discipline	Priority	Building Requirements (gross ft^2)	Cost ($ thousands)* Facilities	Cost ($ thousands)* Equipment	Cost ($ thousands)* Total Costs
Chemistry	1	35,000	5,000	14,000	19,000
	2	412,000	44,700	33,400	78,100
Subtotals		447,000	49,700	47,400	97,100
Electronics	1	130,000	49,000	33,000	82,000
	2	25,000	6,000	8,000	14,000
Subtotals		155,000	55,000	41,000	96,000
Engineering	1	296,500	36,200	39,000	75,200
	2	45,300	8,900	18,300	27,200
Subtotals		341,800	45,100	57,300	102,400
Materials	1	220,000	55,000	62,100	117,100
	2	170,000	29,000	36,400	65,400
Subtotals		390,000	84,000	98,500	182,500
Physics	1	80,000	15,800	9,300	25,100
	2	131,000	25,700	163,300**	189,000**
Subtotals		211,000	41,500	172,600**	214,100**
Summary	1	761,500	161,000	157,400	318,400
	2	783,300	114,300	259,400**	373,700**
Totals		1,544,800	275,300	416,800**	692,100**

*Numbers are rounded to the nearest $100 thousand.

**Includes $150 million for astrophysics high angular resolution imager.

B. DISCIPLINES

B.1. Chemistry

Large facilities are playing an increasingly important role in chemical research. It has been an evolutionary process, starting with opportunities provided by large instrumentation and moving to facilities comprised of clusters of large integrated instrumentation/computational facilities in regional spectroscopic facilities.

Ultra high vacuum chambers with sophisticated analytical instrumentation using laser, electron, and ion cluster beams, together with various spectrometers, are mandatory for leading edge research in many areas of chemistry. Lasers have become important analytical tools to study the dynamics of chemical reactions and to photoinduce reactions. These instruments are usually short wavelength visible or ultraviolet tunable lasers that are themselves pushing the limits of laser technology and hence require considerable expertise and expense to operate and maintain. In addition, many research projects are concerned with the chemistry of materials processing, such as integrated circuit fabrication, that demand clean room facilities by their very nature.

In order to remain globally competitive, particularly in areas of chemistry of importance to DOD, it has been recently recognized that traditional chemical research laboratory facilities at universities are in serious need of upgrading and that shared centralized new facilities are necessary due to the high costs of the instrumentation and environmental control required. This evaluation applies to the two topical areas identified by DOD research managers as candidates for facilities upgrading, based on scientific opportunities and on laboratory needs. These priority topics are laser chemistry and polymeric materials.

Lasers have become a valuable tool in many branches of chemistry. Catalytic activity and selectivity can be studied by using laser Raman spectroscopy to determine the vibrational modes and polarization of structures of molecules adsorbed on single crystal surfaces. High powered photo-ionizing lasers can be used in conjunction with ion cyclotron resonance spectroscopy to study the role of metal ions as selective chemical ionization reagents. Laser induced fluorescence of metallic ions and subsequent transfer of energy to neutral ions may yield superior detection limits, compared to well established analytical techniques that employ fluorescence of neutral metal ions in flames. Two step laser photo dissociation of small molecules can be used to elucidate isotope separation and enrichment processes. In this latter process, an intense pulsed infrared laser vibrationally excites molecules containing the chosen atomic isotope and a second ultraviolet laser photodissociates the molecule, allowing the desired atomic isotope to be collected from the photo fragments. These examples indicate the utilitarian richness of lasers in modern chemistry and illustrate that often they are used in combination with other sophisticated analytical equipment. The facilities investment described here would establish fifteen laser chemistry centers where the operation and maintenance of the lasers would be accomplished by support specialists to serve several research projects. On an even larger scale of centralization, a single free electron laser facility would also be established to provide a very intense and widely tunable source of radiation.

Polymeric materials are found in most military equipment, because of their excellent chemical stability, mechanical properties, and low cost. The majority of the research support for improvements in these materials comes from industry in pursuit of commercial applications, although DOD does support some research specific to stringent military requirements. However, the polymer research of greatest interest to DOD, and for which university facilities upgrades are needed, concerns conducting polymers and polymeric approaches to structural composites, ceramics, and self-reinforcing polymers. It is important to note that independent industrial support of research in these areas is minimal or not aimed at DOD needs.

Conducting polymers that would combine the processability, durability, and light weight of plastics with the electrical conductivity of metal would find a wide range of applications in military systems ranging from solar cells and batteries to integrated circuits and stealth structures. Polyacetylene was the first organic polymer to exhibit electrical conductivity that could range from that of glass to that of metal, depending on the amount of dopants introduced. Doping methods have expanded to include solution doping, ion implantation, and electrochemical doping. Other new polymers have been made conducting, including polypyrrole and polythiophene. Polymer processability and stability are degraded by the doping methods currently used to induce conductivity. Much research is directed at improved doping techniques and on incorporating conducting polymers into nonconducting polymer matrices, as well as fundamental studies to explain the mechanism of electroactivity.

Fiber reinforced composite structural materials are finding many engineering applications, some of which are described under Materials and Engineering. Examples of the Chemistry research topics include organometallic polymer precursors for producing the fibers and self-reinforced or ordered polymers to attain the mechanical properties of fiber-reinforced composites without the need for fiber reinforcement. The most notable of the self-reinforced polymers developed under DOD sponsorship is polybenzothiazole (PBT), which exhibits an extended rigid chain alignment at the ultra-structural level. It offers low-cost processing, by casting and extrusion, instead of the sequence of weaving fibers, stacking of many thin plys, and curing at high temperature required for conventional fiber-reinforced composites.

Other polymeric materials research includes biopolymers, such as the polysaccarides for reduced hydrodynamic drag and non-linear electro-optic polymers for optical signal processing applications. The facilities investment described here would provide the polymer processing and characterization facilities for several focused centers of university research on electrical, optical, magnetic, and structural polymers.

B.2 Electronics

In addition to the traditional subject areas of electronic devices, circuits, and systems, the Electronics research program of DOD encompasses elements of information processing, low energy laser physics, optics, and material growth. For the purposes of this study, the facilities required for the growth of electronic and optical materials are reported under Materials and the low energy lasers, optical circuits, and vacuum tube research facilities are reported under Physics. The information processing research, being closely related to computer science, is not discussed, since, as mentioned in the Introduction, the National Science Foundation (NSF) and the Department of Energy (DOE) have major facilities programs in progress to provide scientific supercomputing access to university researchers. DOD, through the modernization program of the Defense Advanced Research Projects Agency (DARPA), recently made a significant upgrade in university computing facilities for symbolic computing in anticipation of the thrust in strategic computing. The Office of Naval Research is making available to its principal investigators a significant portion of the time of the Naval Research Laboratories' supercomputer at no cost to the existing research contracts.

A strong and clear consensus has emerged from this study indicating that the research managers of the Electronics program within the DOD feel that microcircuit fabrication at dimensions much smaller than those of the Very High Speed Integrated Circuits (VHSIC) program represents the greatest opportunity and greatest research facility need within Electronics. The feature sizes desired are 10 to 100 times smaller than the one-micron regime currently being advanced under VHSIC. It is in this regime that entirely new modes of operation of electronic, optical, and magnetic devices occur, due to the quantum effects produced by the limited number of atoms contained within these small dimensions. These phenomena present the possibility of creating devices whose performance can be greatly superior to that predicted from the bulk characteristics of the material from which they are fabricated. This has already been observed for high speed field effect transistors (FETS), when the device dimensions are reduced below one-tenth micron. It has also been observed that dramatic increases in transmission properties of optical materials occur when very thin layers of material are stacked in a multilayer sequence, offering the possibility of improved photodetectors and lasers.

The fabrication of these novel devices requires very advanced and expensive equipment for the deposition, lithography, and selective removal of the deposited materials. In addition, sensitive analysis of the surfaces and interfaces between dissimilar materials needs to be performed during the fabrication process. This is in contrast to current commercial practice (even for sophisticated microcircuits), where the analysis by electron microscopes and spectrometers is accomplished after the circuits are removed from the fabrication apparatus and before they are inserted into the next apparatus in the fabrication sequence. This requirement for in-situ analysis has greatly increased the minimum cost of doing research on device fabrication.

The facilities in which this instrumentation is housed require extreme control over air purity, to avoid dust particle disruption of the fabrication, and extreme control over vibration, to avoid misalignment of the successive patterns employed in the fabrication sequence. The reliability of these as yet undeveloped circuits is anticipated to be a major concern that is best addressed early in their development, since the failure phenomena are anticipated to be inextricably tied to the fabrication process employed at the microscopic level.

For these reasons, the first priority in microcircuit fabrication was given to the refurbishment and upgrading of up to six university centers for microcircuit fabrication, with a second priority of augmenting two university reliability research centers to work closely on this new class of circuits.

In a separate, but related, research area, reliability at the systems level is perceived to be threatened today by the susceptibility of advanced solid state circuits to electromagnetic interference at relatively modest power levels. Research into hardening weapons systems against intentional enemy electromagnetic interference or inadvertent disruption by radiation from nearby friendly systems is required. The facilities for enabling university participation in this research include anechoic chambers and electromagnetic measurement instrumentation as a first priority, and dedicated computational facilities for modeling as a second priority.

B.3. Engineering

Engineering encompasses the disciplines usually associated with university departments of mechanical engineering, aeronautics and astronautics, civil engineering, industrial engineering, and materials engineering. The subject matter frequently overlaps that of the other disciplines, such as Materials or Chemistry, but is usually closer to a specific end application or requirement. For example, composite structures is a thrust area that has the same ultimate goal as Materials research on structural composites, namely lighter weight and stronger structures for building weapons platforms. The distinction is the focus in Engineering on determining the performance of composites through innovative design and analysis of structures using state-of-the-art materials. Research results are fed back to materials scientists to provide guidance to their endeavors. A base of knowledge about optimal design methods is thereby developed for application to many problems. Proceeding with this example, non-destructive evaluation (NDE) techniques must be developed to enable the engineer to perform these measurements in support of the analysis of composite structures. There is considerable resultant interaction with the materials scientists who also need NDE techniques to evaluate their progress in controlling the composition of materials.

Similarly, the area of Energetic Materials and Combustion involves considerable interaction with chemists to improve propellants, explosives, and fuels. The facilities in these two areas are typically large and have a significant element of concern for the safety of the personnel performing the research. The instrumentation is becoming dominated by lasers and analytical tools similar to that needed in Materials science.

Fluid mechanics and acoustics are the classical, almost exclusive, domain of Engineering, with slight involvement by molecular and chemical physics. The facilities are typified by dedicated wind tunnels and water tunnels. Instrumentation is dominated by automatic digital data acquisition and digital computer modeling and simulation of the phenomena. Laser probes and acoustic sensors with sophisticated signal processing are also mainstays of instrumentation in this discipline.

Manufacturing, design, and reliability have increasingly been moving toward a computer-dominated emphasis on graphics, design aids, expert systems for process control, artificial intelligence to relieve pilot workload in single seat helicopters, and self diagnosis and self repair of machines and weapons systems. Classical industrial engineering, computer science, and structural engineering are very much coming together in this field. The facilities are replicas of factory workcells or simulators of aircraft cockpits and the instrumentation is heavily computer networked. The Defense Advanced Research Projects Agency (DARPA) is making advanced teleconferencing equipment available to several university centers in robotics so they may test their algorithms for robot vision on the DARPA autonomous land vehicle located at a contractor facility. They will also plan to provide replicas of a fingered robot hand to many of these university research centers. Non-destructive evaluation for manufacturing process monitoring and control, as well as for inspection of finished parts and fielded systems, requires a comprehensive research program, which would best be accomplished through a center of excellence in non-destructive evaluation/characterization.

Soil mechanics is uniquely supportive of blast hardened silos, construction, maintenance, and repair of runways, and priority command, control, and communications centers. The facilities at universities are presses, shock tubes, or high-G centrifuges.

B. 4. Materials

Materials research includes the growth of semiconductor, magnetic, and optical materials, as well as processing and fabrication of structural materials such as metal alloys, ceramics, and composites. The processing of semiconductor materials into electronic and optical devices and circuits is reported under Electronics, while the testing of structural composite materials and non-destructive evaluation for both manufacturing and in-process control of materials is reported under Engineering. This traditional division of research responsibility has begun to blur in recent years, and multidisciplinary research teams have been forming in recognition of the strong interaction between material growth, component fabrication, and ultimate system performance. In fact, for optimum coordination, the facilities requirements reported in this section for compound semiconductor growth should be co-located or closely adjacent to the microelectronic fabrication and reliability facilities reported under Electronics.

The greatest potential payoff and also the greatest investment costs are perceived by DOD materials research managers to be associated with two areas: the growth of compound semiconductors and the fabrication of advanced structural composites. High priority at somewhat reduced investment is given to facilities for optical and magnetic materials and for research on structural ceramics.

Compound semiconductor growth has received only a small fraction of the scientific and technical attention that has been spent on silicon. This has been entirely justified to date, since silicon possesses excellent electrical, thermal, and chemical properties, especially with its high quality native oxides and silicides. Being an elemental semiconductor, silicon is significantly simpler from a device processing standpoint than the compound semiconductors, such as gallium arsenide, cadmium telluride, and alloys, e.g. gallium aluminum arsenide and mercury cadmium telluride. The steady doubling of the capability of silicon integrated circuits every two to four years for the past twenty years is evidence of the wisdom of this research investment strategy. It is only recently that the material property limitations of silicon have presented a serious limit to device performance. Research attention is currently turning to at least three ways to get around this limitation. One approach is mentioned in the Electronics section, having to do with new device physics associated with ultra small device dimensions. A second approach, for information processing, is to use artificial intelligence to make "smarter" rather than just "faster" computers. The third approach is to turn significant resources toward the growth and characterization of the compound semiconductors. The facilities investment that is detailed here would permit four to seven university centers to advance the technology of compound semiconductors for signal detection, signal processing, millimeter waves, and communications, to name just a few DOD priority applications.

Composites materials have similar exciting potential for structural applications, ranging from high strength, lightweight airframes and large space structures to lightweight armor for highly mobile combat vehicles. These materials utilize high strength fibers embedded in polymeric, metal, or ceramic matrices. The creation of the fiber itself and the interaction between the fiber and the matrix during the processing largely determine the performance and reliability of the composite when exposed to harsh military environments over its service life. Only recently have advances in analytical tools permitted the microscopic characterization of these materials, both physically and chemically. These tools are both elegant and expensive. The facilities investment detailed here would establish, through new construction and refurbishment, six centers of university research on structural composite materials.

Optical materials are beginning to emerge in communications and signal processing applications. The advances that have been made in optical waveguides using silica glass exemplify the success possible through materials processing research. The combined stringent requirements for low transmission loss and very high tensile strength were achieved through research linking materials structure, properties, and performance. Magnetic materials in bulk form are widely used in critical electrical components, such as electromechanical switches and microwave phased array transmitters and receivers. In thin film form, magnetic materials are used for recording media and non-volatile memory. The facilities investment described here would establish two university centers in optical materials and would augment one existing university center in magnetic materials.

Structural ceramics research of high quality is performed in a number of small university laboratories that are in need of refurbishment and expansion to apply modern microstructural analysis techniques to processing of high temperature ceramics for hostile environments. Both bulk ceramic components, such as radomes for high velocity aircraft, and ceramic coatings on turbine engine components would benefit from this upgraded research capability.

Finally, it should be noted that a segment of the materials research community is dependent upon support from very large research facilities, such as synchrotron and neutron sources. None of these facilities are included in this report. The predominant funding for these national facilities comes from NSF and DOE, with only minor support from DOD. Any decrease in support of these facilities by the other agencies would severely affect the DOD Materials research program.

B.5. Physics

Research on new and improved sources of electromagnetic radiation is a major component of the Physics program of DOD. The free electron laser is a direct result of high risk research funded by DOD. It has demonstrated an entirely new mechanism for generating coherent radiation that is freed from the usual constraints imposed by the need for a material medium. This device has already demonstrated that very wide tunable bandwidth is possible; this has great implications for its utility as a scientific research tool in the analysis of materials, and as a frequency agile radiation source for potential military applications, such as communications and target tracking. Recirculating the electron beam in storage rings offers theoretically high efficiency and hence the potential of high power free electron lasers for directed energy weapons application. The facilities investment reported in this section under coherent radiation sources would refurbish and upgrade three to four existing laboratories performing research on these novel sources.

More conventional lasers for a variety of wavelengths are being explored as tools for research on ultra small integrated circuits, optical computing, catalysis, and molecular biology and for tactical warfare applications such as target designation, optical jamming, and covert communications. The first demonstration of the use of a finely focused laser beam to deposit micron-sized metal connecting lines on semiconductor surfaces occurred under DOD sponsorship in the last five years. It was immediately picked up by the integrated circuit manufacturers as a tool for repairing defects in expensive integrated circuits, and in the photomasks used to produce the circuits. Prior to this breakthrough, lasers had only been used to remove excess material from circuits by vaporizing short circuits and trimming resistors to tolerance. This research continues today under DOD sponsorship and is demonstrating novel methods of doping circuits and of depositing insulators and conductors.

Other laser research projects are attempting to leapfrog over the limitation foreseen in silicon integrated circuits that results from the fact that as much as three-quarters of the surface of these circuits is devoted to metal interconnecting lines between the hundreds of thousands of constituent transistors. The propagation delay of the signals moving on these interconnects at the speed of light is becoming more important in determining the circuit speed than is the switching speed of the transistors. Optical computing chips afford the prospect of distributing the signals by laser beams to many portions of the circuit simultaneously, thereby avoiding the input-output bottleneck of electrical integrated circuits. The facilities reported under optical communications and spectroscopy in this section would establish a new center for optical circuitry and would upgrade an existing laboratory for optical communications.

Directed energy devices require large facilities for research. The high voltages and currents required can only be stored and switched by physically large components as dictated by the scaling laws of electrical power engineering. To some extent this represents a departure from the usual scale of university research funded by DOD, since "big physics" is usually supported by NSF or DOE. DOD has funded university centers in pulsed power, but this has represented only approximately 10 percent of the physics budget. The facilities described under directed energy devices would expand the existing pulsed power centers and upgrade other centers for research on accelerators and microwave and millimeterwave high power sources. Beam propagation and the interaction of electromagnetic energy with materials would also be studied at these centers.

Astrophysics research directly produces knowledge of the background radiation against which space objects must be detected. Secondarily, the advances in instrumentation (optics, infrared, and x-ray) needed to conduct this research improve our military capability to detect and track space objects and to detect nuclear events in space. The major facility upgrade in this section, and indeed, the single highest cost item in the entire report is a $150M high angular resolution imager center whose goal is a hundred-fold increase in image sharpness on celestial objects and space vehicles.

C. SUMMARIES

Laboratory facilities and equipment needs for thrust areas associated with the foregoing disciplines are given in the following summaries. The science and technology implications of laboratory enhancements, and their national security consequences are also addressed.

CHEMISTRY

Thrust Area: Laser Chemistry

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	20,000	3,000
	-- Priority 2 --	
New construction	75,000	9,000
Renovation/expansion	150,000	13,500
Subtotal	245,000	25,500

Equipment: Linear accelerator and storage ring electron sources; upgrade equipment for free electron laser facility to enhance short wave-length beam power; arrays of six lasers (dye, argon ion), with diagnostic, data processing, and beam direction equipment for each of 15 laser chemistry centers.

Priority	Cost ($ thousands)
1	7,000
2	30,000
Subtotal	37,000

Total Cost: $62,500,000

Technical Objectives and Opportunities:

-- Priority 1 --

An upgraded free electron laser laboratory would be established. It would be a high power, high time resolution facility essential to progress in chemical reaction kinetics, surface physics and chemistry, hot carrier electron transport investigations, and high resolution photo emission studies.

-- Priority 2 --

Fifteen laser chemistry centers would be established. This number represents a best estimate of university community requirements to ensure that DOD-sponsored research in the field is conducted in an efficient, cost-effective manner. Centralized laser resources would facilitate the sharing of expensive instrumentation and permit a reduction of maintenance costs through the pooling of technicians and shop facilities. The centers would include picosecond lasers which, especially in the ultraviolet region, offer a new tool for studying the dynamics of chemical reactions.

National Security Consequences: Fundamental knowledge of chemical reactions is crucial to much of military technology, e.g., to the improvement of propellants, explosives, fuels, lubricants, and high energy lasers.

CHEMISTRY

Thrust Area: Polymeric Materials

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	15,000	2,000
	-- Priority 2 --	
New construction	170,000	20,500
Renovation/expansion	17,000	1,700
Subtotals	202,000	24,200

Equipment: Polymer molding; film casting; film and fibers drawing/orientation equipment; integrated scanning transmission electron microscopes and x-ray detector systems; SQUID magnetometers; picosecond spectroscopy systems; Fourier transform nuclear magnetic resonance units; electrophoresis equipment; data processing and analysis instrumentation; dedicated computer resources.

Priority	Cost ($ thousands)
1	7,000
2	3,350
Subtotal	10,350

Total Cost: $34,550,000

Technical Objectives and Opportunities:

-- Priority 1 --

Laboratory upgrades would provide significant capabilities for new polymer research at the molecular level, heteroatom polymer synthesis and characterization, characterization of polymers for electronics, etc. Focused centers would be established for the development of a) a new generation of polymers for electronics, optical, and magnetic applications, and b) composite materials with unprecedented toughness and high temperature capabilities.

-- Priority 2 --

The proposed expenditures would greatly enhance research in the areas of composite materials, ordered structural polymers, and polymer thin films for electronics applications. This in turn would lead to the development of improved dielectrics, capacitors, and electroactive polymers for uses such as piezoelectric sensors.

National Security Consequences: Polymer materials are essential elements of virtually all strategic and tactical weapons systems. High temperature metal matrix and ceramic matrix composites for applications such as radiation-hardened structures and gas turbine blades require high temperature fibers. Other applications include cheap, expendable acoustic detectors for sonic buoys, and a variety of electronic microdevices. Improvements in polymeric materials would enhance the performance, reliability, and maintainability of a wide array of weapons systems and logistics equipment.

ELECTRONICS

Thrust Area: Microelectronic Fabrication and Reliability for Unique DOD-Critical Devices/Materials

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	60,000	30,000
Renovation/expansion	60,000	15,000
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	20,000	4,000
Subtotal:	140,000	49,000

Equipment: Vacuum and plasma deposition; electron beam and x-ray lithography; plasma etching; wet chemical etching; impurity analysis with electron and ion beams; computational support for device modelling and process simulation; environment simulators for temperature, humidity, vibration, and synchrotron light source for surface diagnostics.

Priority	Cost ($ thousands)
1	30,000
2	6,000
Subtotal:	36,000

Total Cost: $85,000,000

Technical Objectives and Opportunities:

-- Priority 1 --

Provide vibration-free facilities for extremely small feature-size (one hundred angstrom) micro-circuit fabrication of devices utilizing technology beyond VHSIC. Electron-beam and x-ray lithographic equipment and plasma and laser enhanced photo deposition apparatus are required. Electron and ion-beam imaging systems for measurement analysis of ultra small structures are necessary.

-- Priority 2 --

Establish research capability in reliability of micro-circuit devices, especially with respect to temperature, humidity, and radiation hardness of ultra small devices. Expand synchrotron analysis capability for analysis of electrical contacts and other natural interfaces.

National Security Consequences: Integrated circuit fabrication is pressing the limits of our knowledge of chemistry and physics, particularly of interfaces between materials, and the utilization of unique materials for DOD devices. Research to provide the knowledge required for further advances in integrated circuits can only come if researchers in university laboratories have access to state-of-the-art fabrication equipment and processes. Reliability of military systems using integrated circuits depends to a large extent on the processes used to fabricate circuits and their stability over time.

ELECTRONICS

Thrust Area: System Robustness and Survivability

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost $ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	10,000	4,000
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	5,000	2,000
Subtotal:	15,000	6,000

Equipment: Electromagnetic generators; anechoic chambers; microwave measurement equipment; propagation ranges; computation facilities for modelling and diagnostics.

Priority	Cost ($ thousands)
1	3,000
2	2,000
Subtotal:	5,000

Total Cost: $11,000,000

Technical Objectives and Opportunities:

-- Priority 1 --

Expand existing facilities for the measurement of electromagnetic propagation, measurement, and system network investigations.

-- Priority 2 --

Provide computational facilities to enhance modeling of electromagnetic interference phenomena.

National Security Consequences: Sophisticated weapon systems are potentially vulnerable to electro-magnetic interference, either consciously induced by enemy forces or unintentionally introduced through radiation from friendly force equipment. Subtle interactions between electronic systems operating on the same platform can degrade performance or completely deny weapon systems availability. Fundamental scientific understanding of means for minimizing these effects is required to supplement the current engineering fixes being pursued.

ENGINEERING

Thrust Area: Combustion

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	57,500	9,250
Renovation/expansion	95,000	8,600
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	9,300	1,250
Subtotal	161,800	19,100

Equipment: Variable high-pressure flow reactors; optical diagnostic instrumentation; chemical analysis instrumentation; vector processors for the simulation of turbulent multiphase processes; dedicated computer diagnostic and analysis capabilities.

Priority	Cost ($ thousands)
1	15,000
2	11,750
Subtotal	26,750

Total Cost: $45,850,000

Technical Objectives and Opportunities:

-- Priority 1 --

Conduct research on improving the energy efficiency of turbine and internal combustion engines, investigate the viability of alternate fuels (e.g., methanol), develop insights into high-pressure, high-temperature combustion chemistry of present and future propulsion fuels, study multiphase turbulent reacting fuels, and observe high altitude and high mach number combustion processes.

-- Priority 2 --

Develop unique facility for studying combustion and plasma phenomena of propulsion systems; anticipated benefits include increased understanding of ramjet and rocket motor instabilities, fire propagation phenomena ignition and flame propagation mechanisms, and plasma/gas dynamic interactions. Upgrade facility for quantitative flow field imaging to advance understanding of phenomena underlying energy conversion, aerodynamics, and propulsion processes.

National Security Consequences: Improve the range, performance, and reliability of aircraft, missile, ship, and land vehicle propulsion systems; enhance payloads, lower operating costs, reduce corrosion and detectable exhaust signatures, increase fuel performance, and reduce engine development time.

ENGINEERING

Thrust Area: Composite Structures

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	5,000	1,180
	-- Priority 2 -- N/A	
Subtotals	5,000	1,180

Equipment: Mechanical testing devices capable of multiaxial and variable loading rates in high temperature environments; real-time non-destructive ultrasonic, acoustic emission and x-ray radiography testing equipment; high temperature test equipment with associated data processing and dedicated computational capability.

Priority	Cost ($ thousands)
1	3,420
2	---
Subtotal	3,420

Total Cost: $4,600,000

Technical Objectives and Opportunities:

-- Priority 1 --

Composite materials have not been exploited to the degree possible, due to a lack of detailed understanding of their response to complex loading conditions, high strain rates, and hostile environments. The proposed facility would likely engender major advances in the understanding of the thermomechanical behavior and failure characteristics of composite materials, with emphasis on high temperature conditions.

-- Priority 2 --

N/A

National Security Consequences: Military applications of composite materials include engine hot sections, nozzles, missile nose cones, aircraft surfaces, lightweight high-strength materials, etc. Improved materials are key to enhancing the performance and maintainability of weapons systems and logistics equipment.

ENGINEERING

Thrust Area: Energetic Materials

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	---	1,000
	-- Priority 2 -- N/A	
Subtotals	0	1,000

Equipment: Mechanical and x-ray diagnostic devices; time-resolved optical spectrometer; electromagnetics effects sensor; gas guns; sample preparation equipment; specialized machine shops.

Priority	Cost ($ thousands)
1	7,000
2	---
Subtotal	7,000

Total Cost: $8,000,000

Technical Objectives and Opportunities:

-- Priority 1 --

A primary objective is the development of a broad class of high performance propellants. A second priority objective is research on energetic materials (explosives, propellants, etc.) which remain inert under shock conditions. This involves theoretical and experimental investigations of atomic and molecular processes in shocked condensed wave materials. Experimental research would provide time-resolved optical, x-ray, electrical, and mechanical diagnostics on materials stimulated by mechanical impactors or lasers.

-- Priority 2 --
N/A

National Security Consequences: Inadvertent ignition of explosives and propellants under mechanical shock and thermal stress is a significant operational hazard, particularly under combat conditions. The development of energetic materials which a) are relatively inert to those stresses, and b) function optimally on command, would mitigate this problem.

ENGINEERING

Thrust Area: Fluid Mechanics and Acoustics

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	7,000	650
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	---	350
Subtotals	7,000	1,000

Equipment: State-of-the-art instrumentation for physical acoustics research including highly stabilized lasers, cryogenic equipment, and digital processing gear for automating signal detection and data processing; instrumentation and support equipment for wind and water tunnel facilities for the upgrading of data acquistion and reduction capabilities. For water tunnels, traverse mechanisms, non-linear wave generators, current generators, and related measuring instruments are needed. Wind tunnel requirements include a multi-axis, three-dimensional laser doppler anemometer, and equipment for generating oscillatory flows.

Priority	Cost ($ thousands)
1	3,600
2	3,350
Subtotal	6,950

Total Cost: $7,950,000

Technical Objectives and Opportunities:

-- Priority 1 --

-- Wind tunnels facilities - provide a national resource for studying turbulent and unsteady flows in Reynolds number regimes typical of subsonic flight, and a second facility devoted to the study of the physics of separated flows and transitioning boundary layers. This research could lead to the development of revolutionary concepts of, and predictive methods for, flow management and control in the flight vehicle environment.

-- Water tunnel facility - upgrade an existing facility to greatly reduce flow noise inherent in present tunnel configurations. This improvement would facilitate research on reducing flow noise due to turbulent boundary layer flow around ship hulls.

-- Priority 2 --

-- Wind tunnel facilities - modifications at two sites to facilitate a) research on the prediction of the transition from laminar to turbulent flow and its impact on vehicle drag, and b) low turbulence flow phenomena with emphasis on associated viscous effects, leading to improvements in aircraft design and control technology.

-- Studies of nonlinear surface wave mechanics to enhance understanding of wave/wave/current interactions, ocean wave/ship wake interaction processes, and associated underwater acoustics, leading to improvements in ship designs, wake signature reduction, etc.

-- Integrated physical acoustics laboratory to facilitate research in sound propagation and attenuation, molecular and chemical physics, and underwater acoustics.

National Security Consequences: The proposed facilities enhancements would support research critical to improved aircraft performance, range, payload, and fuel efficiency. Defense applications of water tunnel upgrades include improved range and performance of ships (surface and submersible), reduction of noise signatures of submarines, and enhanced performance of acoustic sensors through the reduction of host-sensor interference.

ENGINEERING

- Thrust Area: Manufacturing, Design, and Reliability

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	77,000	9,250
Renovation/expansion	55,000	6,250
	-- Priority 2 --	
New construction	10,000	1,200
Renovation/expaansion	20,000	4,500
Subtotals	162,000	21,200

Equipment: Hardware and software for design of component inspectability and manufacturing process control functions; integration of advanced nondestructive testing capabilities with computer-aided mechanical design methods; modernization of dynamic track facility including electronic sensors and displays, simulators, and noise and vibration sensors; human factors diagnostic equipment; avionics gear; combustion diagnostic equipment.

Priority	Cost ($ thousands)
1	10,000
2	3,000
Subtotal	13,000

Total Cost: $34,200,000

Technical Objectives and Opportunities:

-- Priority 1 --

Advances in manufacturing methods having DOD-wide implications for reducing weapons system life-cycle cost, and for enhancing systems reliability, would be pursued. Ancillary objectives include reduced lead times and product development costs, improved productivity and quality control, and reduced inventory costs. A new, unique interdisciplinary manufacturing technology facility emphasizing optimal materials utilization and product reliability would be established. Emphasis would be placed on applications of artificial intelligence concepts to the manufacturing cycle. A second laboratory would be developed for studying the application of computers to the design, manufacture, and control of complex systems, and for the development of advanced composite materials.

Integrated, coordinated research into all aspects of rotorcraft design, manufacturing, and performance at two laboratories is a second objective of the proposed expenditures. Areas of concentration include computer-aided design and manufacturing of rotorcraft components, the study of human factors problems associated with the workload of single pilots in a high performance rotorcraft, stability and control research, and combustion studies aimed at enhancing engine performance.

-- Priority 2 --

Factory of the future concepts would be explored combining manufacturing physics and artifical intelligence, with emphasis on the development of unmanned, self-diagnostic, and self-repairing machines and robots.

Upgrades of two more rotorcraft laboratories addressing the technical issues outlined for Priority 1 would be made possible, with emphasis on rotorcraft dynamics and avionics, respectively.

National Security Consequences: Procurement and maintenance cost-containment are key considerations in the DOD budget. The proposed facilities would support research directed toward these goals. Improved quality control would enhance product reliability. Army mobility rests to a great extent on rotorcraft (helicopter) performance capabilities, including speed, lift capacity, payload, and crash-worthiness. The proposed facility expenditures would address all of these factors in a much more comprehensive manner than is now feasible.

ENGINEERING

Thrust Area: Soil Mechanics

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
	N/A	
	-- Priority 2 --	
New construction	6,000	1,600
Renovation/expansion	---	---
Subtotal	6,000	1,600

Equipment: Four hundred G-ton centrifuge with support apparatus.

Priority	Cost ($ thousands)
1	N/A
2	200
Subtotal	200

Total Cost: $1,800,000

Technical Objectives and Opportunities:

-- Priority 1 --
N/A

-- Priority 2 --
The centrifuge would permit the study of soil and structure phenomena in realistic stress regimes not possible with present facilities. The laboratory would be developed to study both static and dynamic loadings.

National Security Consequences: Research would be applicable to the development of improved structures for missile silos and hardened tactical facilities.

MATERIALS

Thrust Area: Optical and Magnetic Materials

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	10,000	3,000
Renovation/expansion	15,000	2,000
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	10,000	2,000
Subtotal:	35,000	7,000

Equipment: Preparation and handling facilities; high vacuum furnaces; computer-controlled annealing ovens; fiber extrusion and cladding apparatus; grinding and polishing equipment; electron beam microscopes; laser diagnostic facilities; secondary ion mass spectrometers; electron spectrometers; Raman surface spectrometers; high field magnets; casting/grinding/magnetic aligning/sintering equipment operating in "oxygen-free" atmospheres.

Priority	Cost ($ thousands)
1	2,300
2	1,000
Subtotal:	3,300

Total Cost: $10,300,000

Technical Objectives and Opportunities:

-- Priority 1 --

Establish two university centers of excellence in optical materials for both fiber-optic applications and integrated optics circuits for signal processing. Facilities should include material growth, device fabrication, and evaluation capabilities. The centers would generate benefits in such DOD high pay-off areas as durable low loss fibers, laser sources in the ultraviolet and visible wavelength ranges, detectors in the 8-14 micron region, vapor processing/deposition processes, non-linear optical materials, etc.

-- Priority 2 --

Expand existing capability in magnetic materials for improvements in field strength and in temperature operating range of rare earth magnet materials. Research emphasis would be on materials characterization and structure definition using Mossbauer, x-ray diffraction, scanning transmission electron microscope, and neutron diffraction methods.

National Security Consequences: Optical materials are assuming greater significance to defense systems for surveillance, laser designation, and high energy laser weaponry. In addition, optical signal processing may provide an alternate to conventional integrated circuits for information processing. Magnetic materials are currently used in microwave transmitting devices, switching devices, and in non-volatile memory systems for crucial military information processing and communciation systems.

MATERIALS

Thrust Area: Silicon and Compound Semiconductor Growth

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	20,000	15,000
Renovation/expansion	40,000	8,000
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	40,000	10,000
Subtotal:	100,000	33,000

Equipment: Molecular beam epitaxy; metal organic chemical vapor deposition electron beam diagnostics; laser probe diagnostics; mass spectrometry.

Priority	Cost ($ thousands)
1	30,000
2	10,000
Subtotal:	40,000

Total Cost: $73.000,000

Technical Objectives and Opportunities:

-- Priority 1 --

Crystal growth facilities for low defect silicon and for device quality gallium arsenide and gallium aluminum arsenide are required. Instrumentation in this area combines growth with evaluation of materials within the same deposition chambers. By contrast, in commercial practice crystal growth of bulk ingots is performed in an activity separate from the evaluation of the grown material. These facilities are extremely expensive and are in the laboratory apparatus phase currently, with few commerical instruments being available.

-- Priority 2 --

Crystal growth facilities for advanced compound semi-conductors such as mercury cadmium telluride are required for the improvement of optical as well as electronic devices. Relatively little research has been done on the application of modern growth techniques to these compounds, largely because of the attention focused on silicon and gallium arsenide.

National Security Consequences: Integrated circuits are at the heart of most modern military systems, from command and control to smart weapons. The VHSIC program has made a major advance in the capability of these devices, by reducing the feature size down to the one micron regime. Future advances in this circuitry will require greater fundamental understanding of the functioning of conventional integrated circuits. For feature sizes even smaller than this, quantum effects will introduce wholly new device phenomena, presenting major opportunities for advancement in information processing capabilty. Examples of technology applications include infra-red focal plane array detectors, integrated optics, millimeter and microwave integrated circuits, and optoelectronics.

MATERIALS

Thrust Area: Structural Ceramics

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	20,000	3,000
Renovation/expansion	5,000	1,000
	-- Priority 2 --	
New construction	30,000	5,000
Renovation/expansion	10,000	2,000
Subtotal:	65,000	11,000

Equipment: Ball milling and mixing equipment; hot isostatic presses; vacuum and controlled atmosphere furnaces; fume hoods; surface analysis equipment; scanning electron microscopes; secondary ion mass spectrometers; x-ray diffractometers; computational facilities for data acquisition and process modelling.

Priority	Cost ($ thousands)
1	9,800
2	5,400
Subtotal:	15,200

Total Cost: $26,200,000

Technical Objectives and Opportunities:

-- Priority 1 --

Three university laboratories currently involved in ceramics research would be upgraded. The primary benefits include enhanced understanding of the fundamental relationships between (a) ceramics constituents and processing techniques, and (b) material properties, reproducibility, and reliability. Elucidation of these governing factors should greatly reduce the time required to develop improved ceramic materials and composites. Principal research benefits envisioned include development of non-destructive evaluation techniques, methods for the deposition of ceramic coatings using plasma techniques, and development of materials which will tolerate severe thermal shock and sustained high temperatures, and which have uniform, reproducible microstructures.

-- Priority 2 --

Three additional laboratory facilities would be expanded in the context of the above rationale.

National Security Consequences: In hostile environments, metal surfaces oxidize, corrode because of stress, fail because of fatigue, exhibit effects from laser radiation and interfacial phenomena, and are subjected to friction and wear. Ceramic materials are used in extremely hostile environments in turbine engines, rocket nozzles, and electromagnetic windows of high velocity aircraft and missiles.

MATERIALS

Thrust Area: Structural Composites

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	50,000	15,000
Renovation/expansion	60,000	8,000
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	80,000	10,000
Subtotal:	190,000	33,000

Equipment: Vapor deposition epitaxy reactors; filament winders; squeeze casting presses; injection molding presses; textile forming looms; thermoforming presses; servo-hydraulic forming equipment; powder processing and fiber growth equipment; special equipment for ceramics processing; high temperature/high pressure autoclaves; process control computers; diagnostic and modeling computers and graphics.

Priority	Cost ($ thousands)
1	20,000
2	20,000
Subtotal:	40,000

Total Cost: $73,000,000

Technical Objectives and Opportunities:

-- Priority 1 --

Establish four major university centers of excellence in the fabrication of fiber and matrix materials, emphasizing polymer matrix and ceramic matrix materials. Capabilities should include fabrication and layup of small samples and diagnostic materials for the analysis of thermophysical and thermomechanical properties.

-- Priority 2 --

Supplement the above with three to four additional university centers with similar missions.

National Security Consequences: Lightweight and high strength composite materials are increasingly being used in aircraft and spacecraft. These materials combine the high strength of ceramic fibers with the ductility of polymeric or metallic matrices. Significant performance advantages have already been obtained through the use of composite materials, including ceramic matrix composites, and further performance advantages are foreseen, particularly with regard to high temperature capability, laser hardness, armor, and low observables.

PHYSICS

Thrust Area: Astrophysics

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 -- N/A	
	-- Priority 2 --	
New construction	68,000	11,550
Renovation/expansion	35,000	5,100
Subtotal:	103,000	16,650

Equipment: Radio, optical, and x-ray astronomy equipment; upgrade of 100 inch aperture telescope for active optics and interferometric imaging; high angular resolution imager with one milliarcsecond resolution and optical elements of 7 1/2 meters; 4-meter telescope for optical/infrared imaging and spectroscopy.

Priority	Cost ($ thousands)
1	N/A
2	152,065*
Subtotal:	152,065

Total Cost: $168,715,000

* Includes $150,000,000 for high angular resolution imager.

Technical Objectives and Opportunities:

-- Priority 1 --
N/A
-- Priority 2 --

- Expand laboratory capabilities in radio, optical, and x-ray astronomy to study final stages of evolution of stars, formation of neutron stars and black holes, the occurrence of supernova, and to elucidate recently observed non-thermal radio sources.

- Extend existing capabilities in active optics, speckle imaging techniques, and advanced detector programs to existing telescope to produce diffraction-limited imaging of astrophysical sources.

- Establish high angular resolution imager center which exploits advances in optics, sensors, and computer technology to afford a hundred-fold increase in image sharpness on celestial objects (quasar nuclei, stellar, and solar system object surface features) and space vehicles.

- Develop new optical and infrared telescope/instrumentation for astrophysics applications embodying improved precision pointing and tracking, image quality optimization, advances in optical and infrared technology, high speed two-dimensional photon detectors, etc.

National Security Consequences: Advances in astrophysics-related imaging techniques have important applications for the detection and identification of space and non-space objects of military significance. In particular, the technological development of active optics in combination with speckle imaging will make possible diffraction limited observations of objects through the atmosphere. The enhancement of x-ray instrumentation capabilities has application to the detection of nuclear events in space.

PHYSICS

Thrust Area: Coherent Radiation Sources

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	17,000	2,500
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	---	4,000
Subtotal:	17,000	6,500

Equipment: Tunable two-beam two-stage free electron lasers; millimeter range free electron laser; mode-locked laser and support equipment; spectrographs for optical emission spectroscopy; electronic processing equipment (lithographic, deposition, etching); auxiliary interface and support equipment.

Priority	Cost ($ thousands)
1	1,500
2	6,250
Subtotal:	7,750

Total Cost: $14,250,000

Technical Objectives and Opportunities:

-- Priority 1 --

Laser facilities are key assets for a variety of materials and directed energy related research. The cited expenditures would substantially enhance the capability of universities to explore and expand technology horizons in electronic materials, catalysis, corrosion, and molecular biology, among others. Emphasis is on more broadly tunable lasers, which generate coherent radiation over a wide range of energies. This greatly enhances the flexibility available to researchers for analyzing material properties, particular surfaces, and interfaces of importance to solid state electronics and optoelectronics.

-- Priority 2 --

Laser-guided plasma and electron beam facility upgrades will allow the university community to explore more efficiently and comprehensively heretofore unknown aspects of directed energy propagation concepts.

National Security Consequences: Coherent radiation research is critical to a variety of DOD R&D missions, including the design of directed energy weapons, propagation (e.g., "channeling") of charged particle beams, improvement of high power radar technology and electronic countermeasures, advances in ultra-small electronic devices, optical storage and switching aspects of ultra-fast optical computers, etc. High average moderate power tunable lasers are expected to have important implications for tactical applications related to electronic warfare.

PHYSICS

Thrust Area: Directed Energy Devices

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
New construction	---	---
Renovation/expansion	63,000	13,250
	-- Priority 2 --	
New construction	---	---
Renovation/expansion	20,000	4,000
Subtotal:	83,000	17,250

Equipment: Hardware to enlarge accelerator power supplies and capacitor banks; vacuum tube fabrication equipment; large electric discharge chambers; pulsed power generator; high-power glass laser; dedicated data acquisition and analysis computer facilities.

Priority	Cost ($ thousands)
1	6,250
2	4,000
Subtotal:	10,250

Total Cost: $27,500,000

Technical Objectives and Opportunities:

-- Priority 1 --

- Upgrade stellatron accelerator facility as a testbed for high current, high energy accelerators, including screen room and associated diagnostic instrumentation. Facility would generate data of use in the development of compact, high performance accelerators in the non-linear beam interaction regime.

- Establish center for research on thermionic sources of millimeter wave radiation at megawatt power levels. The facility would provide understanding electron-electromagnetic field interactions leading to the development of Rf sources in a regime extending to 30 THZ.

- Develop high repetition rate, high average power pulsed power facilities to support studies in plasma beam propagation, microwave power generation, and the interaction of electromagnetic radiation with materials.

-- Priority 2 --

- Expand center for research on switches and power conditioners for extremely high voltages and high currents. Research in this area is heavily dependent on the existence of specialized facilities.

National Security Consequences: Compact high current, high energy accelerators are key components in charged and neutral particle beam weapons concepts. Thermionic radiation sources are essential components of and/or have implications for fusion power sources, directed energy weapons, and spacecraft vulnerability questions associated with ion clouds in space. High voltage and high current switches, regulators, and storage devices are required to operate directed energy weapons. The development of repetitive and reliable opening switches would remove significant impediments to the practical implementation of all directed energy devices.

PHYSICS

Thrust Area: Optical Communications and Spectroscopy

Laboratory Needs

Facilities:	Building Requirements (gross ft^2)	Total Facility Cost ($ thousands)
	-- Priority 1 --	
	N/A	
	-- Priority 2 --	
New Construction	8,000	1,000
Renovation/expansion	---	---
Subtotal:	8,000	1,000

Equipment: Lasers (stable argon ion, ring, picosecond CO_2, femtosecond dye and YAG, mode-locked glass); transient digitizers; computational and digital signal processing capabilities; scanning electron microscope; optical components with special coatings.

Priority	Cost ($ thousands)
1	1,550
2	950
Subtotal:	2,500

Total Cost: $3,500,000

Technical Objectives and Opportunities:

-- Priority 1 --

Laboratory upgrade would facilitate research leading to a better understanding of the fundamental processes and interactions in semiconductors and microstructures necessary for the development of ultra-fast semiconductor electronic devices.

-- Priority 2 --

- Laboratory improvement would permit detection of weak signals which arise in many photon statistic experiments. For example, the creation of photon pairs through non-linear processes followed by subsequent simultaneous detection (i.e. correlation experiments) generally produces weak signals. Such phenomena could greatly expand communication signal detection capabilities.

- A Center for Optical Circuitry would be established for optical computing. It offers the possibility of great advances in computing speed, capacity, and degree of parallelism over electronic computing. Dramatic new computer architectures are possible, e.g., three-dimensional logic and storage.

National Security Consequences: A wide variety of defense-related technology improvements are based on progress in the development of extremely fast and compact electron devices for digital and analog applications. These include smart weapons and surveillance systems. In addition, secure optical communications have important applications to C3.

CHAPTER V

DISCUSSION AND RECOMMENDATIONS

A. DISCUSSION

The laboratory needs cited in Chapter IV relate to universities already heavily involved in conducting research for DOD. They represent a small subset of the 157 colleges and universities addressed in Tables III-4 and 5, and an even smaller segment of all research universities included in Tables III-2 and 3. The AAU study summarized in Table III-1 equates with this work most readily in terms of the number of institutions covered.

Summary comparisons follow between the prior laboratory assessments cited in Chapter III and the present work given in Chapter IV. It should be emphasized that these comparisons involve the DOD-specific laboratory needs developed in this report as opposed to more general needs addressed in prior studies. Nonetheless, they suggest that the cumulative expenditures discussed in Chapter IV are of reasonable magnitude in the context of general university laboratory needs identified in other studies.

- The AAU data shown in Table III-1 relate to 15 universities, a figure roughly equivalent to the average number of institutions encompassed by defense-related laboratory needs for each of the disciplines cited in Table IV-1. This probably accounts for the fact that, for some disciplines, defense-related totals substantially exceed the AAU report figures. Interpretations of these comparisons must be tempered by the fact that the discipline-specific university populations encompassed within the present study differ markedly from the AAU sample population. A Comparison of Tables III-1 and IV-1 indicates that the defense-related facilities needs cited in this report constitute 43 percent of the AAU Chemical Sciences projections for the period 1982-84, over 100 percent for Engineering (encompassing the Electronics, Engineering, and Materials categories of Table IV-1), and 55 percent for Physics. For projected equipment needs, those of this study exceed the AAU figures by factors of roughly three and six for Chemical Sciences and Engineering. The numbers are comparable for Physics, excluding the astrophysics high resolution imager cited in the present study.

- According to NSF staff, an estimated 50 percent to 70 percent of the $221 million cited in Table III-2 for 1983 university capital expenditures (research and instructional) was devoted to research laboratory facilities. Assuming, for purposes of comparison, a 60 percent figure, 1983 research laboratory expenditures for all universities in the engineering and physical science disciplines total $133 million. To obtain a roughly comparable figure, one can annualize the $275 million of defense-related engineering and physical sciences facilities needs (Table IV-1) over a five-year period. This yields an annual expenditure rate of $55 million. It represents slightly more than 40 percent of the estimated $133 million spent by all universities.

- Research equipment expenditures for all U.S. colleges and universities are summarized in Table III-3 for Engineering, Chemistry, and Physics and Astronomy. Engineering expenditures average approximately $70 million for the two-year period. The NSF Engineering category compares roughly to the combined Engineering, Electronics, and Materials categories of this report, where priority 1 and 2 equipment needs shown in Table IV-1 total almost $200 million. If the $200 million is annualized over a five-year period, approximately $40 million in FY 85 dollars would be spent for defense-related equipment annually. This represents over 55 percent of the average 1982-83 engineering annual equipment expenditures for all higher education institutions. Similar analyses for physics and chemistry suggest that needs in these areas cited in Table IV-1 pro-rated over five years are approximately $35 million and $9.5 million, respectively. The projected annual physics expenditure is roughly equal to the NSF 1982-83 average for all universities, largely due to a $150 million high resolution imager for astrophysics. Similarly, the projected chemistry annual expenditures are 30 percent of the average for all U.S. universities for the two-year period.

- Column two of Table III-4 lists 1982 research equipment expenditures for the top 157 research universities. As in Table III-3, the NSF Engineering category compares roughly to the combined Engineering, Electronics, and Materials categories of this report, whose equipment needs total approximately $200 million. Assuming again that expenditures for defense-related laboratory equipment needs would be spread over a five-year period, approximately $40 million in FY 85 dollars would be spent for this purpose annually. This represents roughly 45 percent of the 1982 expenditures for the 157 universities. Similarly, the five year annual expenditure level for physics from Table IV-1 is over 60 percent of the 1982 equipment purchase level, largely due to the inclusion of the aforementioned $150 million high resolution imager for astrophysics applications. The five-year expenditure level implied for chemistry in Table IV-1 is $9.5 million, or approximately 25 percent of the stated 1982 expenditures by the 157 universities.

- The replacement value of "academic research instrument systems in active research use" for the aforementioned 157 universities is given in Table III-3 in terms of 1982 dollars (Column 4). With an inflation factor of 1.076 applied to the 1982 costs, Table V-1 gives priority 1 and 2 (total) defense-related equipment needs from Table IV-1 expressed as percentages of Table III-5 replacement values. As before, the NSF Engineering category encompasses the Electronics, Engineering, and Materials categories of this report. For the Engineering and Physics and Astronomy categories, stated defense-related needs are quite substantial in comparison with the NSF equipment replacement figures. The Chemistry percentage is substantially lower, perhaps reflecting a proportionately lesser DOD involvement in broad aspects of experimental chemistry.

Table V-I

Defense-related university laboratory equipment needs (Table IV-1) expressed as percentages of replacement costs for all research equipment at 157 leading research universities (Table III-5)

Field of Research	% of Replacement Value
Chemistry	15
Engineering	44
Physics and Astronomy	68

B. RECOMMENDATIONS

A total of $300 million over a five (5) year period is proposed for the upgrading of university laboratories.

1. The priority 1 laboratory facilities needs cited in Table IV-1 should be addressed with incremental funding of a five-year $150 million initiative. The initiative should be a part of, and administered through, the existing contract research programs of the OXRs and DARPA. It is believed that this is the most efficient mechanism for targeting facilities improvement funds toward the highest DOD research priorities. This program would be of equal magnitude (i.e. $150 million expended at an annual rate of $30 million) to the existing University Research Instrumentation Program (URIP) pertaining to equipment, but would be allocated as facilities-earmarked increments to competitive research awards. It would thus differ from URIP in that it would not require the establishment of separate review and award mechanisms. It should be stressed that, in the best interests of national security, neither equipment nor facilities upgrade programs should be funded at the expense of existing OXR and DARPA competitive research programs. Further erosion of the latter would jeopardize the scientific basis for future technological innovation on which our national security depends.

2. The existing URIP program should be extended by three years at its present level of $30 million per year. This, combined with the remaining two years ($60 million) of the present program, would constitute the $150 million required to address priority 1 equipment needs (Table IV-1).

3. Priority 2 laboratory needs should be addressed as a national issue with the involvement of other federal agencies having an impact on the national science and technology base, i.e. the National Science Foundation, NASA, Department of Energy, etc.

4. Very large items of equipment and/or facility needs, e.g. the $150 million astrophysics high resolution imager cited in this report, should be addressed on their merits as individual appropriations rather than as parts of broader, more general funding initiatives.

APPENDIX

STUDIES OF ACADEMIC FACILITIES*

Study	Description of Study	Findings
"Health Related Research Facilities in the U.S. in the Nonprofit Nonfederal Sector" Study by Westat Corporation for National Institute of Health (NIH) (1969)	Survey study to gather data on the amount, age and ownership of space in 1968, the amount of space under or scheduled for construction and the estimated space needed to eliminate overcrowding by 1980	10 m. of 42 m. sq. ft. in unsatisfactory condition -over 50% available space in poor condition -additional 55 m. square feet of space needed by 1980, with 17 m. square feet requiring remodeling
"Higher Education General Information Survey" (HEGIS) Conducted by the National Center for Educational Statistics (NCES) (1974)	Survey of 3,200 colleges and universities including data to estimate facilities needs	-20% of facilities at surveyed institutions in need of replacement (2.3 billion square feet) -$2. billion needed just for remodeling of facilities
"Health Research Facilities: A Survey of Doctorate-Granting Institutions." Conducted by American Council on Education (ACE) with funding from National Science Foundation (NSF) and NIH (1976)	Survey of 155 Ph.D. granting institutions to gather data on status of academic health research facilities, new construction in progress, and plans for expansion in succeeding five year period	-29% of academic facilities for health research in need of renovation or replacement (23 million square feet) -cost estimates to meet needs: $347 million for 1975; $360 million for each of succeeding five years
"National Survey of Laboratory Animal Facilities and Resources" Conducted by National Academy of Sciences (NAS) (NIH Publication No. 80-2091) (1978)	Survey of 922 nonprofit NIH eligible institutions gathering data to estimate facilities needs	-16% institutions reported need for replacement of facilities -38% reported need for remodeling of facilities -47% reported need for additional space

*Source: Linda S. Wilson, "The Capital Facilities Dilemma: Implications for Graduate Education and Research", to be included in forthcoming Brookings Institution study, Bruce L. R. Smith, editor, The State of Graduate Education, 1985.

STUDIES OF ACADEMIC FACILITIES

Study	Description of Study	Findings
Report of Research Facilities Branch of National Cancer Institute on survey of facilities needs in cancer research Conducted at request of National Cancer Advisory Board (1979)	Survey of 106 institutions receiving National Cancer Institute Support gathering data to evaluate current and future needs for upgrading of cancer research facilities	Funding need of $149 million for the period 1980-1985 estimated for cancer research facilities
"A Program for Renewed Partnership" Prepared by the Sloan Commission on Higher Education (1980)	Commission report on federal government/university relations (No data collected)	-Recommendations for competitive program for facilities research grants; $30 million annually for five years, to be allocated by NSF and NIH, to upgrade research laboratories and equipment
"The Nation's Deteriorating Research Facilities: A Survey of Recent Expenditures and Projected Needs in Fifteen Universities" Conducted by the Association of American Universities (AAU) (1981)	Survey of 15 leading universities gathering data on expenditures for research facilities and major equipment and estimates of funding needs for succeeding three year period for faculty research only	-From 1972-1982, surveyed institutions spent $400 million for facilities construction, repair, and renovation -$765 million needed for facilities and equipment over succeeding three year period just to sustain faculty research activities

STUDIES OF ACADEMIC FACILITIES

Study	Description of Study	Findings
Report on academic facilities survey (in 1980-81 Comparative Cost and Staffing Report) Conducted by Association of Physical Plant Administrators, (APPA) (1981)	Survey of 226 institutions with 434 million square feet of academic space to gather data on facilities conditions and projected needs	-$1.85-$2.00/square foot required to eliminate most pressing needs -deferred maintenance need per institution of $9.5 million at universities $1.1 million at four year colleges $.6 million at two year colleges
"Strengthening the Government-University Partnership in Science" Conducted by Ad Hoc Committee of NAS, National Academy of Engineering and Institute of Medicine (1983)	Committee report on federal government/university relations (no data gathered)	-Critical, growing need for replacement of academic science facilities and equipment -recommends comprehensive program for facilities construction and development, acquisition, maintenance and operation of modern equipment
"Adequacy of Academic Research Facilities" Conducted by Ad Hoc Interagency Steering Committee on Academic Research Facilities (April, 1984) National Science Foundation	Pilot study of 25 major research institutions with major study planned to gather data for detailed analysis of the condition of facilities used for science and engineering and medical research. Major study to estimate future needs for construction, remodeling and refurbishment of academic research facilities	-Over succeeding 5 year period all colleges and universities would require about $1.3 billion per year for research facilities alone. (Note: Present level of capital facilities expenditures for academic research, development and instruction is $1 billion per year.)

STUDIES OF ACADEMIC FACILITIES

Study	Description of Study	Findings
Report of Department of Defense (DOD) Working Group on Engineering and Science Education. Prepared by DOD-University Forum (1983)	Working group report on condition and needs of academic science and engineering	Deficiencies in research facilities and equipment acute in most universities
"Report on NIH Experience with Extramural Construction Authority" Prepared by Office of Program Planning and Evaluation, NIH (1983)	Historical comparison of legislative authorities for construction of health research facilities analyzing past facilities funding experiences	-Funding authorities mainly for special, not general, use -Almost all funds made available under grant mechanisms -Recent authorities fail to separate funds for construction and research -None of funding authorities based on systematic analysis of need
"University Research Facilities: Report on a Survey Among National Science Foundation Grantees" Conducted by Division of Policy Research and Analysis, NSF, for Infrastructure Task Group of National Science Board (NSB) (June, 1984)	Survey of 1983 NSF grant Principal Investigators (248 investigators randomly sampled) to determine condition of existing facilities and the impact of facilities on research	-70% facilities had been renovated in last 10 years using 7% Federal $ -30% facilities slated for renovation in next three years -80% of P.I.'s rated safety of facilities as excellent -60% reported having lost some research time in past year due to facilities-related failures; 40% reported graduate students had spent 3 or more days fixing problems created by facilities over past year

STUDIES OF ACADEMIC FACILITIES

Study	Description of Study	Findings
Proposed study of cancer research facilities Conducted by President's Cancer Panel and the National Cancer Institute (Proposed)	Proposed survey study to gather data to inventory the quality and quantity of current research facilities in cancer research	In progress
Facilities Needs in Chemical Science and Engineering Conducted under aegis of the Board on Chemical Science and Technology, National Research Council (In progress)	Survey to ascertain specific facilities data for research and teaching in chemistry, biochemistry, and chemical engineering academic departments	In progress

Mr. **Boehlert**. OK, fine. Thank you.

Could you just summarize the high points for us?

Colonel **Carter**. In essence, as I noted, it looked at five particular areas of chemistry, math, physics, engineering and electronics, and it noted that, it suggested that we institute about a $150 million program to fix the facilities associated with those programs that support DOD research, and probably about another $150 million for the instrumentation within those facilities.

Mr. **Boehlert**. Fine. Thank you very much.

No more questions, Mr. Chairman.

Mr. **Walgren**. Thank you, Mr. Boehlert.

Mr. Brown.

Mr. **Brown**. Colonel Carter, perhaps you or maybe Dr. Young could respond to this question. I'm trying to get a basis for comparison for the situation that exists with regard to the needs of the universities in this area with the problem that exists in the laboratories which are operated by the Department of Defense. I wondered if you could give us a rough idea of what the percentage of funds that are allocated to your DOD-operated laboratories goes to facilities instrumentation and equipment, so that we could have a rough idea to compare with the university situation.

Colonel **Carter**. Yes, sir. Insofar as the in-house laboratories are concerned, recognize that they are funded out of a much broader categorization of funding than just our research, our 6.1 program.

Mr. **Brown**. Yes.

Colonel **Carter**. Indeed, you have 6.1, 6.2, 6.3, and in some cases operation and maintenance type support. And indeed the military construction program for those in-house facilities are out of a separate line item, separate budget activity altogether.

Mr. **Brown**. Yes.

Colonel **Carter**. Our in-house laboratories probably receive around, depending on the fiscal year and which Service and the other needs for military construction-type funding for that particular fiscal year, what I would estimate within the neighborhood of between $30 and $50 million a year for upgrading those laboratories. Recognize there are some 73 of those laboratories that receive that kind of funding.

Mr. **Brown**. Could you translate that into some sort of an approximate percentage figure?

Colonel **Carter**. Out of the science and technology fundings that goes to the in-house laboratories about 30 percent of the $5.3 billion program goes to the in-house laboratories. So 30 percent of $5.3 billion would be about $1.5 billion to those in-house laboratories. Recognize that some of that is passthrough-type money. And of that, say, about $50 million of the $1.5 billion is for military construction. Military construction meaning bricks and mortar and, on occasion, as I mentioned earlier, big facilities such as wind tunnels.

Mr. **Brown**. Yes; we're going to have to—we're going to have a problem in comparing all of these figures because I think basically we're trying to look——

Colonel **Carter**. About 3 percent.

Mr. **Brown**. About 3 percent.

Colonel **Carter**. Yes, sir.

Mr. **Brown**. Would that include bricks and mortar of facilities——

Colonel **Carter**. That includes bricks and mortar and——

Mr. **Brown** [continuing]. Plus large equipment plus instrument——

Colonel **Carter**. It would not include the instrumentation. The instrumentation such as spectrophotometers and computers and that sort of thing would probably add perhaps another 1 percent, 2 percent to it. So we're talking maybe 5 percent.

Mr. **Brown**. Do either you, Colonel Carter, or Mr. Bloch, have any serious problems with the overall scope of the problem? Do you think that a $5 billion program over 10 years for the university needs in these areas is out of line? Is it too much? Or is it too little? Assuming, of course, that we weren't constrained by budgetary factors.

Colonel **Carter**. Well, recognize that no matter what we do we seem to be constrained by budgetary factors. But also recognize that we in defense feel that our Nation's universities are major contributors to our national defense, and they are. We also feel that there are major problems in brick and mortar construction within the universities as well as with the major research instrumentation within the universities, and we need to fix it.

I'm not really sure that $5 billion over a 10-year period is out of line. I think it may be a little short. In our survey, or the report that I mentioned earlier, we only looked at five particular areas and felt that we were only addressing the needs that we, DOD, should perhaps address.

Mr. **Brown**. Surely.

Colonel **Carter**. And that was a fairly substantial sum of money.

Mr. **Brown**. Well, I think we all recognize that we're dealing with a situation which is budget limited and that we have to work in accordance with priorities which are reasonable. But within these frameworks—within this framework we need to determine whether what we're trying to do is reasonable in terms of a solution to the problem. We then have to determine what priority that should have. Right?

Colonel **Carter**. We understand.

Mr. **Brown**. Yes.

Colonel **Carter**. Well, we go through the same prioritization process within the Department. For example, we have a total obligation authority that is established each year by the administration and by the Congress, of course, and we have to fit this program within that total obligation authority. And we have tried to put our research funds toward developing the technology that we think we need because we feel that we can support that very easily and we can define the requirements for it.

And I have a lot easier time, quite frankly, in supporting that and defending it within the Department, as compared to, say, buying a second squadron of F-16's or another ship. I do compete with those kinds of requirements for my research funds and, consequently, it gets a little tough on occasion. But we have been successful over the last 2 or 3 years—with this committee's support, by the way, and to a large degree—of getting our instrumentation program underway and getting our university initiative underway.

Mr. **Brown**. Well, I think we're aware in this committee of the increasing importance that the Defense Department gives to maintaining the science base in the university and the technology base in general. Not just in universities, but in industry and the laboratories. And I don't question what we're moving in the right direction, but I do question sometimes whether our priorities are precisely what might be the most optimal under the circumstances.

Mr. **Young**. May I comment on your question?

In our report, as Colonel Carter mentioned, it suggested that for facilities alone we should be putting in about $150 million over a 5-year period, which is $30 million a year, plus the same amount for instrumentation making it $60 million a year. DOD supports about roughly one-tenth of all the university research. That implies the Government should be putting in about 10 times $60 million, or $600 million. Getting close to your $1 billion number.

And a lot of the support for universities comes from private industry and private foundations and other sources.

Mr. **Brown**. Yes.

Mr. **Young**. So the total of a billion is certainly not way out in the right ballpark.

Mr. **Brown**. Well, the bill only contemplates the Government meeting—what is it—half the burden, and the other coming from other sources. So we're, I think, in agreement on the need to divide the load a little.

Mr. **Young**. Within a factor of 2, anyway.

Mr. **Brown**. Yes.

Colonel **Carter**. Well, the overall question I think perhaps Dr. Bloch could address it better than——

Mr. **Bloch**. Well, I want to comment on your question and answer it directly, and then I want to broaden it also somewhat. I think if you throw out $500 million for 10 years as devoted to facilities that's probably not out of line, and I would be the first one to agree with that. That reflects pretty much the numbers that we see no matter how imprecise these numbers are.

Mr. **Brown**. Yes.

Mr. **Bloch**. But I would also hope that especially in a time of budgetary constraints, and we're living through these times right now and will be living through them over the next few years, that we take a broader view of this whole problem and essentially ask ourselves is the allocation that is going to research and development, and within research and development, is it correct, rather than just focusing on facilities as one thing no matter how important it is.

We have many problems in this area, and I think one can only solve these problems if one really looks at it from an overall approach and then makes the right decisions. And that's what I would push for instead of focusing only on bricks and mortar.

Mr. **Brown**. We're looking to you giving us the overall approach, Mr. Bloch.

Thank you very much.

Mr. **Walgren**. Thank you, Mr. Brown.

Mr. Cobey? Mr. Valentine?

Mr. **Valentine**. Yes, Mr. Chairman.

Mr. Bloch—is it Mister or Doctor?

Mr. Bloch. Mister.

Mr. Valentine. Mister.

I want to ask you just a question or two, and you probably already answered but I didn't understand it. Do you regard this legislation as representing a drastic departure from the position of the Federal Government in the past with respect to its money to go to college campuses for the construction of buildings?

Mr. Bloch. No; I don't think it's a major departure because there was a time in the 1960's, and I wasn't here at that time, so I can only be—so I have to be imprecise, where that problem exactly was addressed by the Federal Government and a large number of dollars were spent, primarily for what I call bricks and mortar. So from that viewpoint, it's not a departure at all because there are precedents to it.

Mr. Valentine. Well, are you saying, Mr. Bloch, that you don't necessarily disagree with this approach as a matter of principle, but it's a question of money, budgetary constraints?

Mr. Bloch. Yes.

Mr. Valentine. If we had enough money to do it that it would be a good thing to do? If we could do this and still finance these other necessary projects and experimentations?

Mr. Bloch. Absolutely. And if you can do it in a balanced kind of a way with all the other needs that we have in this particular area called R&D.

Mr. Valentine. Yes, sir.

Mr. Bloch. So I don't think it's something unusual or it's something which the Government should not do.

Mr. Valentine. Well, I was going to ask you a question about philosophy, but I guess that wouldn't be fair. About the Congress, if this is indeed a new program then how are we going to discharge our obligation to do something about the deficit and continue to support the programs in research and development and the experimentation, and then at this same time get into the business of constructing facilities on college campuses that would be used for many purposes other than—you build a good solid building and it might be there 100 years from now.

Mr. Bloch. Well, I focused in my prepared testimony also on—and we should distinguish, by the way, between short-term and long-term kind of approaches to solve this particular problem. And building new buildings, providing money for new buildings is really a one-shot kind of a solution. The other one is that we're getting into a normal business kind of an approach to the problem by allowing essentially indirect costs to reimburse the universities for the use of facilities, and I address that in my prepared testimony and also what I said before. And that coupled to the research itself as part of the indirect cost structure I think is a very important kind of a facet and we shouldn't lose track of that.

The present indirect cost recovery is not sufficient. Its 2 percent is the use charge that most of the people are using and that essentially makes the assumption that a building lasts 50 years. Well, maybe the shell lasts, or the outside lasts 50 years, but the inside certainly doesn't. And we know that, especially in technologies that require an ever more precise and well-defined kind of environments.

So I think we have an obligation, No. 1, and we have an opportunity, No. 2, to look at these use charges and see if one can't bring them more in line with reality.

Mr. **Valentine**. Thank you, sir.

Mr. **Walgren**. Thank you, Mr. Valentine.

Mr. Henry.

Mr. **Henry**. Thank you, Mr. Chairman.

My questions, really, in probing is very close to the gentleman from North Carolina. I take it, particularly in Mr. Bloch's words to us, there is kind of a begrudging, although very polite, skepticism about the whole thing. Given what I would presume, at least for all practical purposes, as a constraint in any new moneys, I mean you see it as a shift. And we've made this distinction between instrumentation and brick and mortars, and I think that in itself is questionable because a modern laboratory, the building itself is part of the instrument in terms of the kinds of controlled environments there. I'm trying to approach this whole thing from just the whole question of the nature of scientific inquiry. It seems to me, forgetting the exact percentages of how much on your respective budgets are tracked into cost recovery, how much is tracked toward or given to instrumentation, isn't it just a good thing from a scientific point of view every once in a while to upset the applecart a little bit in terms of how the money flows? Isn't it a good thing every once in a while to put a shot in the arm, as it were, to democratize scientific endeavor and to give these institutions an opportunity to shake loose from NSF-directed, or DOE, or DOD-directed contracted research?

I'm just—I'm looking at it that way, and letting those little pockets blossom out where they may. I mean if you did something like this even for 10 years and then went back to what we're doing, doesn't it create a kind of—encourage pluralism in the scientific community, which, after all, is one of the things we wish to sustain? And in the long run aren't you benefited by that?

I guess that's the way I'm looking at this and trying not to get too obsessed with the figures here, but with the concept of just how scientific inquiry goes about. And if we don't do this, do we not find ourselves with increasingly a smaller and smaller circle of participants on a smaller and smaller circle of kind of self-contained, almost habitual ways of looking at things?

You know, I don't want to make this speech back home for the taxpayers because it sounds crazy. But it seems to me in science every once in a while you want to—going to throw money out there and let it do what it will presuming that it's responsibly being applied, but for no other purpose than to allow these facilities to rejuvenate themselves and then chart their own paths.

And I think that's what I see in Mr. Fuqua's bill, and I think that's why virtually all of us are cosponsors of it, as you heard. I think it's that kind of longing.

Mr. **Bloch**. Well, can I comment? I would like to comment on that.

First of all, I don't think I was skeptical or begrudging at all. Because I recognized right from the beginning that there is a problem called facilities, and let's face up to it. How we face up to it, I think that's what the debate and the discussion really should be.

Now, you are broadening the subject somewhat to areas of essentially distribution and to areas of bringing new people into the mainstream of the scientific and engineering enterprise of the United States, and I have a lot of sympathy with that. And I have a lot of interest in it, and I've talked to a number of the members of this committee about that particular subject. I'm not sure that the right approach to that one is, however, through bricks and mortar. I'm not sure of that because bricks and mortars by themselves don't make for good research. You need people, and you need equipment, and you need instrumentation. And broadening the participation, that I am also very concerned about and would like to see something done about it. I think approaching it in a more direct kind of a way than bricks and mortar might give us better results. And I just throw that out for your consideration.

Mr. **Henry**. And my concern, if I may, Mr. Chairman, is on the flip side. If the only way you can get the bricks and mortar and instrumentation is through this directed contracted research, you've cut yourself off from that diversity that every once in a while has to have a kind of blank check support to get off the ground and then do its own thing.

Mr. **Bloch**. Well, there are those two approaches, and I gave you my view on that.

Mr. **Henry**. OK.

Mr. **Walgren**. If the gentleman would yield. To pursue the same thing, isn't it right, Mr. Bloch, that to the degree that you emphasize providing facilities through indirect costs or related costs associated with a peer-reviewed research selection that you may very well, after you've made that selection, have locked everybody else out of that area completely?

Now, at least when we peer review individual research contracts, in theory, if you don't get the contract this year you can apply next year and you might succeed in getting a contract in that area. But once you don't have the facility, if the facility went with the contract initially in the year 1985 through 1987, then you can't come back in 1988 and say you would like to do that work because you don't have the facility and the other person does. And so we in a sense have not only concentrated it, but we have locked up the research in certain given locations and then thrown away the key.

Would that not be the correct flip side of funding facilities through this kind of mechanism?

Mr. **Bloch**. I can imagine that there are instances where that could happen, no doubt about it. If there is only, and I'll take as an example one accelerator being built, OK, and then you give it to one particular location or you make the decision that it goes to one location and there is no other accelerator for the next 10 years, you are certainly correct, OK, that you threw that key away.

But I would suggest that both facilities, instrumentation and research, come in different size packages. And that doesn't mean that, if you step away from the example of accelerator and look at other things that next year there is another chance of doing exactly the same thing again because there will be a program in that particular area. And second, I think as I said before there are programs that one can think about that bring institutions up to higher levels of accomplishment in the research area which not necessarily—where facilities are not necessarily the most important aspect, but where instrumentation and people building is a more important aspect. So there are probably examples on all sides.

Mr. **Walgren**. I think the gentleman——

Mr. **Henry**. I yield.

Mr. **Walgren**. Mr. Bruce.

Mr. **Bruce**. No questions.

Mr. **Walgren**. Mr. Barton.

Mr. **Barton**. No questions.

Mr. **Walgren**. I had another one. I wanted to be clear that in our choice of indirect costs, of recommending indirect costs as opposed to the concept of allocating a fixed proportion of an agency's budget, Mr. Bloch, you mentioned in your testimony that the cost of meeting the capital side would probably be drawn from funds that would otherwise be available to fund the research. And what I wanted to see if you would agree with is that that's necessarily true no matter where we get the funds, isn't that correct? That if funds are directed toward facilities, then by definition they're going to, at least under present circumstances, come from funds that might otherwise be available for the actual conduct of the research?

Mr. **Bloch**. Well, you're absolutely correct in that. The only thing I would like to say on that particular point, that the amount of money in any year could be considerably different. Example—if I take the number $500 million per year, and then compare that one even against a 5-percent use charge, for instance, or today's 2-percent kind of a use charge, the cost to the Federal Government, it could make a significant difference on a year-to-year basis, even though over a period of time it equalizes itself out. The $500 million come out of 1986 or 1987, depending what the year is. The 5-percent would come out of that year, also, but it would be a smaller amount across all of the departments.

And by the way, since you are bringing up the subject of indirect cost, let me just mention for the record that the NSF indirect cost allocation is also 45 percent, just like in Department of Defense. And the numbers that I used before, the $270 million for instrumentation, equipment and facilities, did not include this particular indirect cost, or that portion of the indirect cost number that would apply to it. So we are spending more than $270 million if you include the indirect cost. I just wanted to clarify that.

Mr. **Walgren**. And I think that's true in your case, also.

Colonel **Carter**. That's true. Yes.

Mr. **Bloch**. So I think it has to do—to answer your question, it has to do with taking it out in one chunk per year or more equally distributing over a longer period of time.

Mr. **Walgren**. I guess it's not surprising to see an agency as sensitive as the NSF allocating a substantial amount of money in this area. And I guess from an overall perspective I would wonder whether other agencies are as sensitive to that, and I think the evidence is that as consumers of science they aren't quite as sensitive as the NSF is with its focus on potential. The other agencies would be more ready to simply get a given piece of research done and not really worry about the future.

And the question would be, given the fact that much of our research capacity is funded by the less sensitive agencies, at least as far as the responsibility for the future goes, shouldn't we be reaching for some kind of arbitrary reinforcement of future capability so that we don't lessen our potential by focusing on the very near term? Don't we need a mechanism that will actually drive what you might call an investment factor in this area to be sure that particularly in budget-strained years we don't buy only the near-term product that we're after, which is the research this year, and neglect the longer term investment that must be made to sustain the future years?

Wouldn't you think that given the propensities to focus on the near term, particularly in budget-stressed years that we ought to build in a kicker on the investment side?

I address that to both of you.

Colonel **Carter**. If you would like me to go first. Recognize that as we are a mission agency then our focus is slightly different than the National Science Foundation. And you're absolutely correct in that we are a user of research and research products and we do a good bit toward the creation of those research and research products, also. But we potentially could have a short-term focus. However, we have tried to address that from the two aspects that I mentioned earlier. A focusing on the education of scientists and engineers to be able to assure a continued supply of scientists and engineers; and, second, toward the instrumentation programs.

Now, one thing that may occur, and we have been approached several times lately by various delegations from State governments in our university research initiative, is they're willing to build brick and mortar facilities to accommodate a multidisciplinary engineering or scientific research program that we may be willing to put in their particular State. So that's a source of revenue I believe that could be readily tapped for this purpose.

Mr. **Young**. Could I just add to that? That the URIP Program—University Research Instrumentation Program—had precisely your kind of thinking behind it. We plan it for five years at $30 million a year. Right now the NSF is putting in 20 percent of their program into instrumentation and equipment and we're putting in 15 percent. We're a little short of NSF as of now, but it's in the same ballpark.

Mr. **Bloch**. If I may comment on it. I agree fully with you, Mr. Chairman, that that is a very important consideration. We are worrying many times about our—about bricks and mortars, that investment. But the intellectual capital that has to be replenished also is many times shortchanged. And it wouldn't be at all out of line to have a use charge for basic research apply to much of our applied and developmental kind of research.

Mr. **Walgren**. I guess it is a question of balance. I don't know how to strike that balance, but I guess the idea is you have the personnel resources which you just indicate are often shortchanged, but you also have the facilities side. And what we apparently see now is that we have a certain amount of support for the intellectual capital. We were falling short on the instrumentation, so a factor of investment was directed toward instrumentation. And now the question is in order to strike the right balance shouldn't we also direct a factor of investment toward longer term facilities than just the instrumentation in fear of the emphasis on the short-term investing only in the intellectual capital?

Let me ask another question. And I apologize for taking the time, but we have a vote, which means we have to break and so we could conclude with this panel now, and it gives me time to ask one more question. And that is would the idea of an indirect recovery, relying on indirect cost recovery, that would mean that the university would acquire it and they would borrow the whole amount to build the facility. Now the indirect recovery, is it your view that it would cover substantially, or really completely the current carrying costs of that debt that was required in order to build the facility, or would we be dividing that with the universities so the result of indirect cost support in this area would be essentially to increase the indebtedness charges that the university has to struggle to carry from year to year?

And also, in addition to the indebtedness factor, can we commit to them for the time period that is—that their debt contract would require? If a university is to build a new facility and they have to borrow the money to do it, obviously they have to know that they can be compensated for that work that goes on in that building for the next 20 years. Can we make that kind of commitment that would enable them to attract private capital?

Mr. **Bloch**. Let me take—you asked a number of questions, by the way. Let me see if I understand it correctly.

Let me go to the last point. We are doing that today. For instance, I'll give you examples. Super computer centers. The universities are using debt to finance the installation of the facilities. We are committing on a year-by-year basis because we have no other thing—there is nothing else we can do. However, it's recognized by the universities and by the lenders that the foundation will stand behind this particular program for 5 years, 6 years, depending for how long the debt requirement is. So there is an implicit understanding.

Is it a firm commitment and a legal commitment on our part? A lawyer probably will tell you it's not, but it's pretty well understood.

And I would say the same applies to facilities. You know, if you put a facility up, if we are funding programs in that particular area, we make essentially an assertion that says that particular university and that particular institution can continue to do the same work on an excellent basis over and over and over again. We're making that assumption. Sometimes that's true and sometimes it is not true. But I don't think it's a big problem.

I talked primarily about the depreciation schedules; namely, taking the building and then depreciating it in a meaningful kind of a way that reflects the true life of that particular program and recovering for the university that particular investment. And I think some of the other things like interest costs and so forth could—I think are part today of the indirect base anyway. So I don't think we have—that's a new idea.

Mr. **Walgren**. Would you like to comment at all, Colonel?

Colonel **Carter**. Well, I think as Mr. Bloch indicated, that the depreciation that we permit is really not adequate to meet the requirements, and it's something that I think we should take a look at.

Mr. Walgren. Well, all right. Well, let me on behalf of the subcommittee thank both of you for coming. We appreciate it very much, and look forward to interaction with you on this subject.

And we will break then for 10 minutes in order to respond to this rollcall, at which point we'll bring the next panel up for testimony.

Colonel **Carter.** Thank you, sir.

[Recess.]

Mr. Walgren. Well, let me call us back to order. And I wondered where the audience was. It came to the table as witnesses.

This panel, we would like to welcome you on behalf of the subcommittee. And I will introduce you with your titles for the record, so that we have it on our recording system and you won't have to fully identify yourselves as you give your testimony.

This panel is made up of Dr. Jerome Rosenberg, the associate provost and dean, Faculty of Arts and Science, University of Pittsburgh. And we particularly welcome both Dr. Rosenberg and Dr. Charles Hosler, vice president for Research and Graduate Studies from Pennsylvania State University.

Where is Dr. Hosler? There you are.

Good you're both here. Want to welcome you on behalf of those from Pennsylvania on the congressional level.

And at this point I'd like to recognize our colleague, Congressman Barton, to introduce Dr. Anderson. It is a matter of good form around here. And we're pleased, Congressman Barton, that your constituent is here.

Mr. Barton. Well, thank you, Mr. Chairman.

I am honored to have the opportunity to introduce Dr. Duwayne Anderson. He is the associate provost for research at Texas A&M University, which is in my district. Dr. Anderson joined A&M as a provost for research in 1984. He was formerly at the State University of New York where he was dean of science and mathematics. He has been the chief scientist for the U.S. Antarctic Research Program with the National Science Foundation, the principal investigator on the NASA Viking Mission to Mars. He is the author of more than 150 scientific articles and other publications. He is currently—has total responsibility for the research administration budget at Texas A&M. That budget last year was $139.8 million, one of the largest research budgets of a university in the Southwest.

He is here to speak on the bill H.R. 2823, of which I'm a cosponsor, as you're well aware. I support this effort. I'm going to have to leave before this testimony, but I have reviewed it and I support it. And I ask that the committee give him the fullest courtesy and respect as he testifies before this committee.

Mr. Walgren. Thank you very much, Congressman Barton. And we certainly appreciate your involvement in this area and your support for the discussions and the efforts that many make.

And we'll have a shorter form for the record but with no less emphasis, I would like to say William Baker, the vice president for budget and University Relations, University of California; Dr. Leighton Sissom, chairman of the Engineering Deans Council, with the American Society for Engineering Education; and Dr. John Wright, the president, University of Alabama, Huntsville.

Gentlemen, welcome to the committee. We appreciate all that goes into your testimony and your making yourself available as resources to us.

As I said prior to the other panel, written statements will be reproduced in full, so feel free to highlight or summarize and underline those points that you would like most to focus on. And let's go through the panel in the order in which we called you. And so let's start with Dr. Rosenberg.

STATEMENTS OF JEROME ROSENBERG, Ph.D., ASSOCIATE PROVOST AND DEAN, FACULTY OF ARTS AND SCIENCE, UNIVERSITY OF PITTSBURGH, PITTSBURGH, PA; CHARLES L. HOSLER, JR., Ph.D., VICE PRESIDENT FOR RESEARCH AND GRADUATE STUDIES, PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK, PA; DUWAYNE M. ANDERSON, Ph.D., ASSOCIATE PROVOST FOR RESEARCH, TEXAS A&M UNIVERSITY, COLLEGE STATION, TX; WILLIAM B. BAKER, VICE PRESIDENT FOR BUDGET AND UNIVERSITY RELATIONS, UNIVERSITY OF CALIFORNIA, BERKELEY, CA; LEIGHTON E. SISSOM, Ph.D., CHAIRMAN, ENGINEERING DEANS COUNCIL, AMERICAN SOCIETY FOR ENGINEERING EDUCATION, WASHINGTON, DC; JOHN WRIGHT, Ph.D., PRESIDENT, UNIVERSITY OF ALABAMA, HUNTSVILLE, AL, ON BEHALF OF THE AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES

Mr. ROSENBERG. I want to thank the subcommittee very much for having extended the invitation to me to speak on behalf of our university, which I think is typical of all research universities. I will try to be brief because I think many of the basic facts and issues are understood.

First of all, I think everybody recognizes that there is a problem. Facilities have a tendency to wear out, and much faster, as we heard in the first session this afternoon, than the 50-year rate that the current indirect cost allowances recognize. We have new problems in facilities, to involve containment of hazardous materials, magnetic shielding, provision of especially clean or sterile environments, a combination of instruments that are larger or heavier than the original laboratory may have been designed to accommodate. So it is something that all universities are struggling to deal with, the problem of renewal or modernization of facilities.

And my own feeling is that universities and their State governments, in the case of those institutions that are State supported, are not ducking their own responsibility, but we are asking and what this bill under consideration recognizes is for some measure of Federal partnership in the question of facility maintenance and renewal.

As was mentioned in the first session, there was about a decade following Sputnik and through the sixties when the Federal Government was very active in this field, and there has been very little since then. Now, I welcome the Important Notice from the National Science Foundation that Mr. Bloch spoke of this afternoon, but there are a number of features of the Fuqua bill which I find very attractive, and some of these points came out in the discussion earlier. So let me mention some of the things that I find desirable in the bill.

First of all, it is a systematic bill that allows for a long haul, a 10-year commitment, so that institutions can plan in an orderly way for submission of proposals as they find that they are willing to do that.

Second, the bill would provide for open competition and peer review. I think it is the frustration of the absence of a Federal role in assistance for facilities renovation and renewal that led over the past few years to some ad hoc random arrangements in which some universities came directly to the Congress and asked for special legislation to fund research facilities. And I think Congress probably would be pleased to have some regular way of dealing with this issue so that it need not be approached in these unsystematic modes.

Peer review I think, although not the only criterion for supporting the scientific enterprise by the Federal Government over the past 40 years, has certainly been an essential one. And I believe that the peer review system has led to a very high quality of the scientific enterprise in the United States, and I want to emphasize that both the competitiveness and the peer review are things that I think have advantages in the Fuqua bill as compared with some of the other techniques that have been proposed.

Now, with respect to the concern expressed by the two agency representatives who were here earlier this afternoon, universities also are sensitive to this. And I would like to make a proposal which I think that maybe not only this subcommittee, nor even this full committee could deal with, but which I hope the Congress can deal with in the coming years.

As I understand it, of the some $20 billion of Federal funding toward civilian R&D per year, about $5 or $6 billion is used to support activities through universities and colleges. I would like to see an opening up of this distribution, and I would point out that a mere shift of 2½ percentage points of the total $20 billion toward the university sector would cover the added costs of funding the renovation called for in the Fuqua bill.

Now, this may seem like self-serving on the part of a university spokesman, but I would like to offer two reasons why I believe that this proposal serves the national interest:

One, when we must select from among competing priorities, a preference for basic research over technological development ensures continued and long-term progress in the fundamental discoveries of science from which all applications must flow. In addition, basic research is conducted mainly with university or public funds. Developmental activities do have a greater access to funds from the private sector because they are closer to a potential commercial payoff.

The second reason why I believe that a modest shift as I indicated would serve the national interest is that American university research activity is intimately bound up with the training of graduate students. Mr. Bloch spoke earlier this afternoon about problems of intellectual capital that must be supported as well as physical facilities. But it is the intimate connection between the training of scientific personnel and university research which marks the American research system as distinct from the system by which research is mounted in most other countries of the world.

In this country the major senior scientists do work in day-to-day contact with graduate students, and I believe that this feature has helped this country remain competitive in an age of rapidly changing scientific conceptualization. And what I fear is that if our universities do not have the resources to perform scientific work at the most sophisticated level our young scientifically inclined people will forego graduate training and be siphoned off either to less intellectually challenging positions in applied technology or to other occupations altogether.

I know that time is pressing upon us and I am not going to go on to other matters which were covered in my written testimony, but I just want to add certainly my endorsement not only of the intention of this bill but, with some of the details which I already discussed, some of the actual features of the proposed legislation.

Thank you very much, Mr. Walgren.

[The prepared statement of Dr. Rosenberg follows:]

TESTIMONY ON UNIVERSITY RESEARCH FACILITIES
TO THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

October 22, 1985

By Jerome L. Rosenberg
Dean, Faculty of Arts and Sciences, and Vice Provost
University of Pittsburgh

My name is Jerome L. Rosenberg. Trained as a physical chemist and physical biochemist, I have spent my entire professional career, since completing my Ph.D. in 1948, at three universities, Columbia University, University of Chicago, and University of Pittsburgh, in teaching, research, and academic administration. Since 1969 I have been Dean of the Faculty of Arts and Sciences at the University of Pittsburgh.

I am pleased to have the opportunity to speak to this sub-committee on the construction and modernization of research facilities, particularly on the role of the federal government in this area. My own university is probably typical of American research universities in experiencing the obsolescence of some of our main scientific laboratories. Although we have had the good fortune to receive support from the Commonwealth of Pennsylvania and some private donors for the construction of a number of new buildings for science and engineering, we have not had the resources to plan systematically for the regular replacement or modernization of these facilities. Even the first science building constructed as part of the modern wave on our campus, for our Departments of Biology and Psychology, is now 30 years old, at what would be the end of a useful life in an industrial research laboratory. Moreover, we still use five buildings for science departments which were built more than 60 years ago.

We, along with other research universities, have struggled to find funds for renovating some of these older structures. We must adapt our buildings to meet new requirements, including more rigid electrical and plumbing specifications, containment of hazardous materials, magnetic shielding, provision of specially clean or sterile environments, and accommodation of instruments that are larger or heavier than the original laboratory was designed to accommodate. The financial burden of modernization is too great for universities to handle alone, even with support from state governments, industry, and private foundations. What has been missing is the partnership role of the federal government.

We are pleased that the Congress, including the sub-committee, has been addressing this issue. For the past 40 years, the federal government has developed a splendid program for the support of research and training activities at universities in a rational and, for the main, predictable manner. Within the past three or four years the major federal agencies supporting research have recognized another need and have initiated programs to help the academic communities to acquire major items of scientific equipment, including expensive common instruments that serve a number of investigators. Only in the 12- or 15-year post-Sputnik period, however, was there a significant federal presence in the financing of construction and modernization of scientific laboratories.

We are pleased that the Fuqua Bill, H.R. 2823, is being debated in the Congress. The current concern is a recognition of the partnership role of the federal government, along with universities, state governments, and the private sector, in renewing university research facilities. Not least of the desirable features of the bill is the charge it would give to the National Science Foundation to inventory and assess the facilities needs of our universities, which we currently can only estimate from fragmentary surveys. We feel that the problem is severe, but we are not sure of the magnitude of the problem and the cost required to solve it.

Another desirable feature of the bill is the regularization of the process by which federal funds would be allocated. In the absence of a systematic program for federal intervention in the financing of research facilities, we have seen random efforts by some universities, frustrated by the seriousness of their severe problems, to invoke the political process through the device of special ad hoc legislation. An important negative trade-off of these developments has been the absence of an opportunity for fair competition among all universities and the absence of an informed peer-review process, needed to guarantee that federal funds will be used for facilities whose use fits into the determined priorities of the research-supporting agencies and meets established quality tests for the proposed research activities and for the designated investigators. The traditional peer-review which has been associated with federal funding of scientific activity for the past 40 years, although not the only criterion used in allocating funds, has been one of the reasons for the excellence of American science since World War II.

One of the interesting features of the Fuqua Bill is the built-in assurance of a ten-year period. This will allow a more orderly spacing of proposal submissions and awards in terms of a natural time distribution of facility obsolescence than would be possible with a single-shot program or with a short-term program whose extension is not guaranteed.

Another desirable feature of the bill from a public policy perspective is the cost-sharing feature which assures a stretching of the impact of the federal funds to at least twice the federal financial commitment.

The only negative feeling I have heard about the bill is the fear that, after the initial year of special funding, the facilities program might exert a toll on the research project budgets of the six agencies and that we might lose some capacity to fund exciting new research proposals and to launch the research careers of promising young faculty. This fear is particularly felt in the biomedical area because of the memories of the recent sustained effort required by both Congress and the academic biomedical research community to overcome administrative intentions to impose harsh limits on the number of new and competitive renewal awards by the National Institutes of Health.

On balance, however, I feel positively about the Fuqua Bill and would leave to future Congresses the task of appropriating adequate funds to the six agencies to preserve at least the current level of support for research and research training. Both research projects and facility funding can be maintained with minor adjustments within the current total federal budget. As I understand it, between 25% and 30% of the total federal expenditures for civilian research and development are channeled through universities. This distribution reflects the differential allocations for basic research, done mostly at universities, and for development, done mostly outside universities. A shift of just an additional 2-1/2% of the total federal R and D expenditures to the university sector would cover the cost of facilities financing envisaged in the Fuqua Bill, without increasing the total federal R and D budget and without sacrificing the research project funding capabilities of the six agencies.

My comments may appear to some to be self-serving for the academic community. I think not, and I offer two reasons why I believe that my proposal serves the national interest.

(1) When we must select from among competing priorities, a preference for basic research over technological development insures continued and long-term progress in the fundamental discoveries of science from which all applications must flow. In addition, basic research is conducted mainly with university or public funds. Developmental technology, on the other hand, has access to resources from the private sector, which can anticipate and measure short-term outputs which are related to product development.

(2) American university research activity is intimately bound up with the training of graduate students. The cooperative

activity of graduate students with the most creative and productive of our senior scientists is a distinctive feature of American science education, the feature most likely to develop new cohorts of scientists who will help this country to remain competitive in an age of rapidly changing scientific conceptualization. If our universities do not have the resources to perform scientific work at the most sophisticated level, our young scientifically inclined people will forego graduate training and be siphoned off either to less intellectually challenging positions in applied technology or to other occupations altogether.

Of course, as this sub-committee well knows, the proposed University Research Facilities Revitalization Act of 1985 is not the only instrument through which the federal government supports scientific activities. I would like to speak briefly about just one other area of government encouragement to academic science, the research and development tax credits to support basic research, embodied in the Economic Recovery Tax Act of 1981, the provisions of which are to expire at the end of this calendar year. This program has encouraged, through tax credits, the donation by corporations of valuable scientific and technological equipment to universities for the support of research. This program has been a stimulus for basic academic research, at relatively low cost to the federal government. I would hope that the Congress will act favorably on current legislation which would extend these tax-credit programs.

I want to thank the sub-committee for the invitation to present testimony at this hearing.

Biographical Note

Dr. Jerome L. Rosenberg did his undergraduate work at Dickinson College, Carlisle, Pennsylvania, and received his graduate training in physical chemistry at Columbia University, where his Ph.D. was awarded in 1948. During the 40s he was associated with the SAM Laboratories of the Manhattan Project in New York. He went to the University of Chicago in 1948 as an A.E.C. Postdoctoral Fellow in the Physical Sciences and remained there until 1953 as Research Associate (Assistant Professor) in the Institute of Radiobiology and Biophysics. He joined the faculty of the Department of Chemistry at the University of Pittsburgh in 1953 and transferred to the Department of Biophysics and Molecular Biology as Professor and Chairman in 1969. His fields of research included photosynthesis, photochemistry, and molecular spectroscopy. His published work includes numerous research articles, a pedagogical book in chemistry, and a non-technical book on photosynthesis. Since 1969 he has been Dean of the Faculty of Arts and Sciences at the University of Pittsburgh and he has also held the title of Vice Provost since 1978 in addition to his departmental appointment as Professor of Biological Sciences.

Mr. Walgren. Thank you very much, Dr. Rosenberg, we appreciate that summary and those points that you underscore.

Let's then turn to Dr. Hosler.

Mr. Hosler. Thank you, Mr. Walgren. It is indeed an honor and a pleasure for me to have an opportunity to express myself on this bill. I guess I speak with some vested interest in it. I don't think a day goes by in my working life when I don't encounter some plea on the part of a faculty member or a department in the university as to space availability or equipment availability to do something that they have a burning desire to do that they feel will be very important to the development of science and engineering in this country. So I'm reminded every day of what we're addressing here today.

We represent I guess on this globe about 6 percent of the population of the globe and probably some proportionate amount of the resources of the globe. The only difference really in the competitive struggle we find ourselves in in the economic realm or in the military realm really is our level of education and the degree to which we have exploited the ideas and the innovative propositions that our scientists and engineers come up with.

It used to be that a pencil and paper were enough to develop your ideas, and maybe a calculating machine, but nowadays the freedom to really investigate and explore your ideas is so much tied up to the types of things we're talking about, to both buildings and the availability of sophisticated equipment. I can remember a big deal, when I was a young instructor, was to spend $300 for a microscope. The last microscope I helped to acquire cost $500,000, for a transmission electron microscope, plus another $300,000 investment just to make a room suitable to house the microscope. Until we got done it was a $1 million enterprise. This is characteristic of the research enterprise today. So in order to exploit our ideas, we now need equipment and multimillion dollar systems in some particular cases.

Even in the nonhard sciences such as anthropology and areas such as this, we now find that access to computers is very important; and access, again, to sophisticated chemical analytical equipment to employ in anthropology as apart from the standard engineering fields we usually talk about. Access to this equipment is as important as anything else. I'm sure we can't build all of these facilities on every campus, but I think we're going to have to think hard about how we can provide people the travel money or the subsistence for short periods of time so that they may access these large machines which are not going to be available on every particular campus.

Another thing that I encounter in my daily work is that nowadays the salaries across the country are all pretty competitive, but the difference between being able to hold a research team together and to compete for the brains of the country very often is the type of facility and the type of equipment to which you can give these scientists and engineers access.

Another point that I think is important is some people speak with some shame of the fact that the United States has depended very heavily for hundreds of years on the import of good minds from elsewhere in the world. This is one place where the balance of trade has always been in our favor; primarily due to the freedom to investigate and the political freedoms we have in this country, but also nowadays it's more and more tied to the availability of sophisticated laboratories and equipment. That isn't often discussed, but I think it's something we ought to keep very well in mind; that we want to remain an attractive place for the best minds of the world. Not that we don't want to cultivate and develop our own talent, but at the same time I think we've come to be dependent on being able to tap the world and should continue to be, and will continue to be dependent upon that.

The talent competition, just as the economic competition, is a global competition. I think American universities need not only to compete with the RCA's, and the GE's, and the Bell Labs; but we need to compete with the laboratories of the world to keep the best brains available to our students and to have their input into our economy.

I also would like to comment briefly on some of the previous discussion about using indirect costs to acquire equipment. I think that's the way it probably should be done, but probably we have not wisely invested the money we got from this source in the past wisely. We had to use it for day-to-day operating expenses. But also I think the indirect costs which we negotiate with people from the Federal Government almost always are not replacement costs, but based on the original cost of the equipment and based on the original cost of building. Again I would cite that in my particular institution one building that we built for a quarter of a million dollars in 1929, is still in active use and we are spending $6 million this year to renovate, and that building is carried on the books presumably at a quarter of a million dollars. Many of our older campuses I think suffer from this. If you have recently built a lot of buildings, then this is built into your indirect cost recovery. The fact that you have a lot of very old buildings that have been put to very long and good use sometimes legislates against you if you want to recover your costs through the indirect cost mechanism.

The other thing I would say is that while I fully endorse the intent of this bill, and as every one here has indicated this is a very serious problem for our Nation to replace these facilities and equipment, I would be willing to suggest that knowing what the constraints are in the Federal budget that you might want to reduce the matching. I think from the standpoint of someone at a large State university even a 30-percent match, a 30-percent up front amount from the Federal Government would be adequate to leverage funds both from private and industrial and State sources. But I think it is important that there be a matching component to this. I don't believe anyone should be able to get away with getting the money completely from the Federal Government. Even a 50-percent match is generous, and it might spread the money a little more widely and reduce the net cost to the Federal Government if the match were perhaps reduced to as little as 30 percent.

I think I'll conclude my comments there.

[The prepared statement of Mr. Hosler follows:]

TESTIMONY OF

DR. CHARLES L. HOSLER

VICE PRESIDENT FOR RESEARCH AND DEAN
OF THE GRADUATE SCHOOL

THE PENNSYLVANIA STATE UNIVERSITY

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

COMMITTEE ON SCIENCE AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

ON BEHALF OF

THE PENNSYLVANIA STATE UNIVERSITY

OCTOBER 22, 1985

INTRODUCTION

I am pleased to have this opportunity to testify in support of the objectives of House Bill 2823. Penn State and many other universities desperately need new equipment and facilities. We are taking some steps to solve the problem, but our resources are unequal to any quick resolution. The aid you are considering is most welcome and necessary.

The thread connecting the modernizing of research facilities and equipment to a prospering society is the flood of ideas, knowledge, products, and processes that come from research. We compete daily in a world in which we hold a minority share of people and natural resources. And, we are being rudely buffeted by foreign competition.

The American spirit of innovation, the rich diversity of culture, the broad spectrum of educational opportunities, and the free enterprise system give this nation a potential to compete that is unmatched anywhere on the globe. The political freedom we enjoy must continue to be matched by the same freedom of expression in the arts, sciences, humanities, and engineering.

Exploitation of the latter freedoms has become more dependent on large and expensive data and investigative systems. Pencil and paper gave way to computers, the eye was supplanted by a myriad of complex systems that "see" for us on scales both large and small. Only a generation ago, the investigative power offered by such systems was unimaginable. Accumulation of knowledge through the written word is still paramount, but the independent thinker now needs computers and communications to begin to stay abreast of advancing technologies. To do original work in many fields, the scientist uses multi-million dollar systems. Modifying, replacing, maintaining, and updating these systems is part and parcel of the research effort.

If we cannot offer reasonable up-to-date research facilities, then we at Penn State and my colleagues across the country cannot:

> . . . attract the best faculty researchers or retain them in the face of the Bell Labs, the IBMs, the RCAs,
> . . . recruit better students, undergraduate as well as graduate,
> . . . train students in the latest research methodologies,
> . . . interest business and industry in the cooperative ventures so useful to us and the private sector, and
> . . . do the first-class science required by the Department of Defense, other government agencies, and business and industry.

Nor should the trade balance with respect to scientific and artistic talent be forgotten. Outstanding research facilities not only help to keep the best people here, they attract overseas talent as well. Freedom to create and investigate has always been a magnet for great minds; access to state-of-the-art facilities is now an important part of that freedom.

BACKGROUND

Seldom does the academic community respond with one voice on any question. But 90 percent of those responding to a National Science Foundation survey of priorities said that their top priority was upgrading and expanding their research equipment. Of the 4,000 questionnaires distributed, only seven did not provide the requested data. Another NSF survey of 43 universities revealed that 25 percent of their equipment is obsolete. An NIH report dated April 1985 estimates that only half the instrument systems in the biological and medical sciences performed well and that systems not considered state-of-the-art comprised nearly 80 percent of all instruments in actual research use.*

Half the nation's basic research goes forward at universities, which casts the current facility and equipment shortfall in perspective. Basic research is our bread and butter product. Knowledge from it builds the base for many industrial research and development groups as well as university applied-research units. Not only is traditional R & D in the physical sciences and engineering shortchanged; the computer era has extended equipment requirements to every field from anthropology and economics to the library. If one excludes the "super systems" such as particle accelerators and the like, the biological sciences today are as equipment intensive as physics and chemistry, and some social sciences are close behind.

SUGGESTIONS

It is extremely important that the broadest possible spectrum of academic researchers have access to large instruments and computer systems. To do this, in addition to financing more such systems, your committee should consider travel and subsistence funds for investigators. For computers, remote access is developing and must be encouraged. This kind of support might do much to decrease the instability and disruption now inherent in the games of musical chairs often played by productive researchers. It is apparent that access to modern laboratories and equipment is as important as salary in attracting good minds to promising research fields. (I speak from the vantage point of 25 years as a Penn State administrator.) Broader access, therefore, would diminish some of the disruption that can make a productive mind unproductive, if he or she relocates and begins the laborious task of rebuilding a strong support staff and equipment bank. Certainly, advantages can be assigned to the establishment of facilities in new locations to tap human resources, but major losses can occur if this policy excludes the modernizing of existing facilities and denies support of already productive laboratories.

Any group writing legislation to revitalize research equipment should be watchful for the old syndrome of program stops and starts glued to the waxing and waning of perceived national needs. Such acceleration and braking leads to large inefficiencies and energy losses. I would support any legislation that would include phasing of support so that available resources might be more thoughtfully and efficiently applied. Management by crisis seems to be the way we live, and in the case of research equipment we have a crisis. We need, however, to do better than crisis reaction.

I am concerned that this proposed legislation would take equipment funds from ongoing research budgets. The goal of revitalizing the research equipment bank is meritorious, but the setting aside of dollars from the pool of research funds is bound to damage some science, particularly that done under smaller grants. We must nurture some of the people whose ideas might be labeled "radical" and who tend to work on a shoestring. These projects sometimes lead to the quantum leap advances that drive new technologies. The difficulty of supporting these fringe people as well as funding the more conventional investigators who seek incremental steps in knowledge is perhaps best framed by noting that NSF already turns down roughly two out of every three highly rated proposals. How much more difficult to attract grants if funding is cut by this legislation. I urge you to craft this bill so as to do minimum harm to current funding levels. This my chief caveat about House Bill 2823. These research grants not only fund ideas but perhaps more importantly, graduate students who will continue to generate new ideas. The likelihood that a scholar will advance knowledge is what we invest in a research proposal, but in reality, the probability that his or her graduate students will advance a given field is even greater.

I commend you for the matching funds idea. That should help us leverage industrial money, and since Penn State ranks third in the nation in attracting business and industry grants, we feel quite good about this feature.

THE PENN STATE SITUATION

If incremental funds become available, most universities can present lengthy lists of facilities and equipment. Penn State can do the same. We have already moved to solve some of the worst problems. Last year, we purchased $28 million worth of equipment and facilities. Renovations have been announced for 600,000 square feet of space. The $27-million cost is much less than the expense of new space. Another 600,000 square feet of space is required to house research and graduate degree programs ranging from greenhouse studies to environmental pathogen-free labs for plant and animal research. New analytical laboratories, a pilot plant fermentation unit for biotechnology, and ultra-clean fabrication rooms for electronic ceramics and thin films are necessary. Unfortunately, we are years behind. For example, Penn State will shortly become the home for a high-temperature ceramic materials center supported by the Gas Research Institute, and off-campus space will have to be rented or temporary housing erected until a permanent solution can be found. The campus simply does not have sufficient space or equipment for new research thrusts in spite of careful review of the use of currently available space. This shortage hampers productivity of research and graduate study more than any other factor, and it severely limits our ability to respond to government and industry initiatives.

Penn State planning documents show a backlog of capital projects put at $107 million and equipment priced at $33 million. Maintenance has been deferred that will cost us $2.6 million per year extra in order to catch up over the next decade (deferring these expenditures is another way that Penn State finances major equipment purchases). Unless we can find far more support, we see no solution to a problem that can only worsen as the main campus physical plant ages. Our current physical plant is valued at $800 million. Over the next five years, Penn State estimates that it must spend $300 million on new buildings and renovations. It is not apparent where these funds will come from.

CONCLUSION

The land-grant universities are imbued with the spirit of educating the sons and daughters of the working class and have contributed greatly to the growth and strength of our country through broadening our educational base and permitting a broader segment of our population to achieve its intellectual potential. We have, at the same time, been primary sources of new ideas and have delivered those ideas and innovations to the farms and factories of the country.

We cannot afford, as a country, to have this great impact reduced for lack of ability to provide the physical facilities and equipment.

We look to you for help, and appreciate your sensitivity to this problem. Although the final formula might be adjusted, House Bill 2823 is a strong move to modernize the country's university research facilities.

Mr. **Walgren**. Thank you very much, Dr. Hosler, we appreciate it.

Let's then turn to Mr. Baker.

Mr. **Baker**. Thank you very much, Chairman Walgren. I very much appreciate the opportunity to testify before you today on the subject of higher education facilities and instrumentation needs.

These hearings are significant I believe because they indicate that the facilities and instrumentation problems that afflict universities and colleges are national problems, and deserve the Federal Government's special attention. To meet the challenges of an increasingly complex and competitive world, our Nation's citizens must be well-educated and well-trained, and our factories and farms provided with the latest and most productive technologies. Our Nation's universities furnish much of this necessary training and technology. Yet, much of the facilities and research equipment that are used for education and research are dangerously obsolete and in disrepair.

The seriousness of this problem is suggested by the fact that one-third of higher education's physical plant was built before 1950, and university research equipment is at present estimated to be twice the median age of private industry's. Twenty-five percent of all research equipment in the leading universities is, for all practical purposes, obsolete, while only 16 percent is estimated to be state of the art. This unfortunate condition exists despite the Nation's reliance on higher education to conduct over half the country's basic research effort.

At the University of California, we had come to believe that our physical plant was seriously inadequate to meet our teaching and research responsibilities. However, we lacked hard data, and so 3 years ago undertook a careful, detailed, and realistic review of our facilities needs for the next decade. We learned from the survey that the nine campuses of the University of California face serious facilities problems. The existing plant is deteriorating and dramatic changes in science and high technology disciplines require that existing facilities undergo significant alteration or be replaced. Enrollment shifts among disciplines and emerging programs result in the need for additional academic facilities. These physical conditions limit the University's ability to maintain the scope and quality of its existing programs and respond to the rapid changes in knowledge.

The first problem that we face is obvious; that is, buildings deteriorate. Deterioration and maintenance problems are particularly acute at our older campuses. Over one-fourth of our Berkeley campus buildings, for example, were constructed before 1921. To keep more than the 3,500 buildings on our nine campuses functional and to eliminate an enormous backlog of deferred maintenance, our survey indicated the cost to be nearly $1 billion over the next decade.

A second kind of facilities need occurs because the University's academic programs must change over time to keep pace with the latest advances in each discipline. This means facilities must change also. Rapid technological development of the kind experienced in the biological sciences, for example, affects not only the kind of equipment needed in a laboratory, but also the kind of building systems required to support that laboratory. Modern genetic engineering laboratories, for example, must have sophisticated systems for ventilation, waste disposal and safety. Requirements like these make older buildings obsolete.

Shifting enrollments among disciplines is a third factor in our facilities needs. Enrollments in engineering and computer science courses have increased sharply since 1975, for example, while enrollments in the physical sciences have remained fairly stable, and those in the social science and humanities have declined. Nearly 80 percent of the university's need for instruction and research space is for projects in the high technology and science disciplines. Simply reassigning space will not solve the problem because the amount of space needed for laboratory instruction is at least five times greater than space for a humanities program, thus construction of new space is needed above any possible reallocation associated with the renovation of existing facilities. We estimate that the University of California will require about $1.6 billion over the next decade for renovating and constructing facilities that house isntruction and research programs, libraries, and related academic facilities.

Finally, a fourth facilities problem is produced by new governmental regulations that require us to update facilities continually in order to meet changing health and safety codes, provide handicapped access, and, particularly in California, meet seismic safety requirements.

Thus, if the University of California is to main vital and contribute to the Nation's well-being, it must have not only enough facilities for its essential activities, but also the appropriate kinds of facilities to support its programs as they change and develop. To renovate, maintain and construct the facilities we need and operate, our inventories indicate that the University of California at its nine campuses must spend an estimated $4 billion on facilities in addition to more than half a billion dollars to replace obsolete research equipment over the next decade.

We found these sums, as I'm sure you will, to be truly staggering, especially in the context of the relatively low levels of support the university receives from outside funding sources. Although it may be surprising for a publicly supported university, our capital development in recent years has been funded not primarily by the State government, but by the university itself through user charges, private fundraising, hospital revenues and reserves, and student fees.

The Federal Government has a history of responding to the needs of the Nation's universities and colleges, and of investing in them in ways that address national priorities. This is an urgent need now for a substantial Federal investment in facilities and instrumentation for higher education.

We strongly support the intent of Chairman Fuqua's proposed H.R. 2823. The most important component of the act is its intent to provide $10 billion in Federal and matching funds for university and college facilities over a period of 10 years. The facilities and instrumentation problem is truly measured in the billions of dollars, and the size of the funds described in the act not only brings some financial relief to higher education, but draws attention to the magnitude of the issue. Indeed, as Chairman Fuqua pointed out on July 30, the bill symbolizes the Federal Government's awareness of the seriousness of the facilities problem, and the need for Federal action on a major and sustained scale.

We do have a concern, however, that Federal facilities funding does not come unduly at the expense of investigator-initiated research activities. Therefore, we think it essential that the startup facilities, the funds for startup facilities be authorized in the bill as—be appropriated in order to minimize the amount that may be redirected from research funding. The University of California supports the Association of American Universities' recommendations for the act that seek to restrict facilities funding in the event that the startup funds that Chairman Fuqua proposed are not appropriated.

Furthermore, we recommend that the legislation explicitly include some sort of ceiling, perhaps 10 percent, on the proportion of an agency's budget that can be used for facilities purposes. Currently, there is no provision in the bill that limits the amount of investigator-initiated research funds that may be diverted into facilities expenditures. While higher education must significantly improve its physical plant and instrumentation, we must not stunt the very research we seek to enhance.

In closing, let me say that if the University of California's experience is typical, and we believe that it is, major funding is needed by universities and colleges throughout the Nation for facilities renewal and construction and for related improvements in research instrumentation. The private sector, the States, and the universities themselves must all make this revitalization effort a high priority. The Federal role is particularly critical here because the task of refitting our Nation's laboratories is both national in scope and central to the country's long-term economic, scientific, and technological well-being.

Thank you very much, Chairman Walgren.

[The prepared statement of Mr. Baker follows:]

STATEMENT OF

WILLIAM B. BAKER
VICE PRESIDENT, BUDGET AND UNIVERSITY RELATIONS

ON

HIGHER EDUCATION'S FACILITIES AND INSTRUMENTATION NEEDS

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

OCTOBER 22, 1985

Chairman Walgren, members of the Subcommittee, I am William B. Baker, Vice President of the University of California. Thank you for inviting me to testify before you today on the subject of higher education's facilities and instrumentation needs.

These hearings are significant because they indicate that the facilities and instrumentation problems that afflict individual universities and colleges are national problems, and deserve the federal government's special attention. To meet the challenges of an increasingly complex and competitive world, our nation's citizens must be well-educated and well-trained, and our factories and farms provided with the latest and most productive technologies. Our nation's universities furnish much of this necessary training and technology. Yet, much of the facilities and research equipment that are used for education and research are dangerously obsolete and in disrepair. If this nation is to educate its citizens and create the knowledge that is the technological foundation of our economy, our security, and our way of life, we must replace higher education's backlog of obsolete scientific equipment and related facilities. Just as the federal government finds it in the national interest to repair the country's deteriorating public roads, bridges, and harbors, the federal government must assist higher education replace its own worn and wearing out infrastructure.

The seriousness of this problem is suggested by the fact that one-third of higher education's physical plant was built before 1950, and university research equipment is at present estimated to be twice the median age of private industry's. Twenty-five percent of all research equipment in the leading universities is, for all practical purposes, obsolete, while only 16 percent is estimated to be state-of-the-art. This unfortunate condition exists despite the nation's reliance on higher education to conduct over half the country's basic research effort.

At the University of California, we had come to believe that our physical plant was seriously inadequate to meet our teaching and research responsibilities. However, we lacked hard data on that subject, so three years ago we undertook a careful, detailed, and realistic review of our facilities needs for the next decade. We learned from the survey that the nine campuses of the University of California face serious facilities problems. The existing plant is deteriorating. Dramatic changes in science and high technology disciplines require that existing facilities undergo significant alteration or be replaced. Enrollment shifts among disciplines and emerging programs result in the need for additional academic facilities. These physical conditions limit the University's ability to maintain the scope and quality of its existing programs and respond to rapid changes in knowledge.

The first problem we face is obvious; buildings deteriorate. They must be maintained on a regular basis, they must be periodically restored with new paint, light fixtures, floor coverings, roofs, and other replacements, and after half a century or so their systems for heating, ventilation, and power must be replaced. Deterioration and maintenance problems are particularly acute at our older campuses. Over a quarter of our Berkeley campus buildings, for example, were constructed before 1921. To keep the 3,500 buildings on our nine campuses functional, and to eliminate an enormous backlog of deferred maintenance, our survey indicated the cost to be some $1 billion over the next decade.

A second kind of facilities need occurs because the University's academic programs must change over time to keep pace with the latest advances in each discipline. This means facilities must change also. Rapid technological development of the kind experienced in the biological sciences, for example, affects not only the kind of equipment needed in a laboratory but also the kind of building systems required to support that laboratory. Modern genetic engineering laboratories must have sophisticated systems for ventilation, waste disposal, and safety. Use of electron microscopes requires vibration-free space and sophisticated electrical systems. Requirements like these make older laboratories obsolete.

Shifting enrollments among disciplines is a third factor in our facilities needs. Enrollments in engineering and computer science courses have increased sharply since 1975, for example, while enrollments in the physical sciences have remained fairly stable, and social science and humanities enrollments have declined. Nearly 80 percent of the University's need for instruction and research space is for projects in the high technology and science disciplines. Simply reassigning space will not solve the problem. Because the amount of space needed for laboratory instruction is at least five times greater than space for a humanities program, construction of new space is needed above any possible reallocation associated with the renovation of existing facilities. We estimate that the University of California will require $1.6 billion over the next decade for renovating and constructing facilities that house instruction and research programs, hospitals and clinics, libraries, and related academic activities.

Finally, a fourth facilities problem is produced by new governmental regulations that require us to update facilities continually in order to meet changing health and safety codes, provide handicapped access, and, particularly in California, meet seismic safety regulations.

Thus, if the University of California is to remain vital and contribute to the nation's well-being, it must have not only enough facilities for all its essential activities, but also the appropriate kinds of facilities to support its programs as they change and develop, and it must ensure that those facilities are publicly safe and secure. To renovate, maintain, and construct the facilities we need and operate, our inventories indicate that the University of California must spend an estimated $4 billion on facilities in addition to more than half a billion dollars to replace obsolete research equipment over the next decade.

We found these sums to be truly staggering, especially in the context of the relatively low levels of support the University receives from outside funding sources. Although it may be surprising for a publicly-supported university, our capital development in recent years has been funded not primarily by the state government, but by the

University itself, through user charges, private fundraising, hospital revenues and reserves, and student fees. Between 1978 and 1981, nongovernmental funds provided an average of 77 percent of the University's capital expenditures, state funds accounted for 22 percent, and federal contributions for only 1 percent. In the past few years, our state's governor and legislature have renewed their strong financial support for the University of California.. However, it is still true that if state funding continues at the levels of the past 5 years, only about 20 percent of the necessary funding will be forthcoming. The University's facilities will deteriorate further, needs for new facilities will not be met, and our academic programs will have suffered significantly.

The federal government has a history of responding to the needs of the nation's universities and colleges, and of investing in them in ways that address national priorities. There is an urgent need now for a substantial federal investment in facilities and instrumentation for higher education. As you know, the major agencies of the federal government that sponsor university research have accepted partial responsibility for addressing the instrumentation problem. In recent years, for example, the National Science Foundation, the Department of Defense, and the Department of Energy have each provided for instrumentation in their research programs. Congress has also appropriated $31.9 million for an instrumentation program in the National Institutes of Health. In addition, for the first time in 14 years, Congress employed Title VII of the Higher Education Act to appropriate $28 million for facilities funding. Recently, Congressman J.J. Pickle introduced legislation (H.R. 1188) that would make permanent the three-year research and experimentation tax credit established in 1981, and would add provisions that should stimulate corporate equipment donations to universities and colleges. The University of California is encouraged by these federal initiatives that seek to assist higher education in this area.

We strongly support the intent of Chairman Fuqua's proposed University Research Facilities Revitalization Act (H.R. 2823). This Act addresses a national problem in a coordinated fashion that involves all the major federal research agencies, with a proposed level of financial assistance that takes seriously the dimensions of the issue. Although, as I have noted, several federal agencies have established programs to fund university instrumentation and facilities, these programs differ greatly in their size and scope. The Revitalization Act brings a systematic purpose to these programs, and extends the responsibility for aiding higher education's facilities needs to all major research agencies. Some of the coordination provided by the Act comes in the form of a nationwide facilities survey to be administered by the National Science Foundation. As the University of California learned, such a survey is necessary if the federal government is to identify the range of the facilities problem.

The most important component of the Act, however, is its intent to provide $10 billion in federal and matching funds for university and college facilities for a period of ten years. The facilities and instrumentation problem is truly measured in the billions of dollars, and the size of the funds described in the Act not only brings some financial relief to higher education, but draws attention to the magnitude of the issue. Indeed, as Chairman Fuqua pointed out on July 30th, the bill symbolizes the federal government's awareness of the seriousness of the facilities problem, and the need for federal action on a major and sustained scale.

We are concerned, however, that federal facilities funding does not come unduly at the expense of investigator-initiated research activities. Therefore, it is essential that the start-up facilities funds authorized in the bill be appropriated, in order to minimize the amount that may be redirected from research funding. The University of California supports the Association of American Universities recommendations for the Act that seek to restrict the growth of facilities funding in the event that the start-up funds Chairman Fuqua proposes are not appropriated. Furthermore, we strongly recommend that the legislation explicitly include some sort of ceiling, 10 percent for example, on the proportion of an agency's budget that can be used for facilities purposes. Currently, there is no provision in the bill that limits the amount of investigator-initiated research funds that may be diverted into facilities expenditures. While higher education must significantly improve its physical plant and instrumentation, we must not stunt the very research we seek to enhance.

In closing, let me say that if the University of California's experience is typical, and we believe that it is, major funding is needed by universities and colleges throughout the nation for facilities renewal and construction, and for related improvements in research instrumentation. The private sector, the states, and the universities themselves must all make this revitalization effort a high priority. The federal role is particularly critical here because the task of refitting our nation's laboratories is both national in scope and cental to the country's long-term economic, scientific, and technological well-being.

Mr. **Walgren**. Thank you very much, Mr. Baker.

Let's turn to Dr. Anderson.

Mr. **Anderson**. Mr. Chairman, I'm very pleased at this opportunity to speak in favor of House bill 2823. I will not take the time to go through all that is contained in my written statement. I would draw your attention to some of the things in the beginning parts of it in which I refer to statements made earlier in introducing this resolution and in earlier hearings. I wish to affirm them also as being true in my experience.

Our university system in the United States is respected throughout the world because of the practical benefits that it has yielded to our country, and it is being emulated in all of its essential aspects throughout the industrialized nations of the world now and in the newly emerging nations.

I think it's important, although I won't go into detail, to consider again some of the trends that have been described earlier. Research expenditures, the investment of research personnel in major nations throughout the world have always yielded increases in standard of living and in improving the quality of life in these countries. And for this reason the emerging countries of the world are following the same basic strategy for growth and development.

It's important I think to recognize that one of our major economic competitors in the world—Japan—led the world in terms of growth in research expenditures for a 15-year period beginning in 1965 to 1980. They also led in the investments of manpower during that same period.

I think that you might be interested also to realize that the results of this investment in terms of the gross national product per capita in Japan rose from a value of $150 per person in 1950 to slightly more than $9,000 per person in 1980. This compares to figures in the United States of a gross national product per capita of about $2,000 in 1950 to $11,000 per person in 1980.

During this period of time the numbers of educated individuals in the labor force rose in Japan from less than 1 percent to a level now that compares favorably to that in the United States and exceeds the numbers of individuals with college or university degrees in Western Europe.

My testimony today is going to emphasize the fact that the Nation's university research infrastructure has been neglected to such an extent that now it is not possible for us to fully utilize the trained scientists and engineers that we ourselves produce. This is especially troubling because today scientific advances are to an extraordinary degree paced by the access to scientific instrumentation and equipment of increasing speed and power and versatility.

As previous testimony has stressed, we are limited today by obsolete and inadequate equipment and facilities. And in spite of 10 years of determined efforts by our State Legislature in Texas, we in the universities of Texas feel particularly constrained and handicapped by our inability to acquire research instrumentation and equipment in the quantities and at a rate that will provide for the full utilization of the abilities of our scientists and engineers. We urgently need the assistance provided for in House bill 2823.

There is another aspect of this problem that I would like to emphasize today, and it was referred to in the earlier session actually.

We have throughout the last decade and a half experienced the classic tragedy of the commons. When I used that phrase the other day, someone asked me to explain it as it pertains to research.

Most of you, I think, know that the tragedy of the commons refers to the practice in England of apportioning land to landowners around the base of a hill or a plateau and allowing the less fertile, rock-strewn land above to be reserved for common use. Individuals were allowed to graze their pastures with their herds, and so forth, in whatever fashion they, themselves, deemed appropriate; and if they had need of the commons, they were allowed to release their cattle to graze the commons. Without regulation the result was inevitable. Landowners increased their herds beyond the carrying capacity of their own pastures and overgrazed the commons to the point that there was nothing there for anyone.

And I would characterize our situation today with regard to the research infrastructure in our universities as not greatly different from that.

House bill 2823 will restore the earlier and more desirable characteristics of our partnership, which began as a response to a serious challenge from abroad, and the Government decided that it would invest in its universities research programs because they would be needed in the immediate future and in the long-term future as well.

What we have seen during the past decade and a half is a situation where as funding pinches generally in research budgets, program directors and contract negotiations to pay attention to the missions of their respective agencies, and to get as much mileage as possible out of the expenditure of every government dollar for research, we saw a shift in attitudes from the investment posture that characterized the earlier relationship to an attitude that can be described as a procurement for services attitude.

And during the past decade or so, this attitude that research is a commodity to be procured at the lowest possible cost in our universities has led to what I refer to as the tragedy of the commons and the deterioration of the research infrastructure.

We need to return to the earlier posture in which the Federal Government takes up its role in the general partnership which involves universities, the private sector, Federal and State Governments.

Now in Texas today we are concerned with the need to diversify the economic structure of our State. We are thought of around the Nation as being extraordinarily well off. There is no question that during the past decade or so, Texas has benefited from the rising prices for oil and gas. But even before that happened, and certainly now, the citizens of our State knew that this was a resource that was being rapidly depleted. We are anxious now to diversify the economic structure of our State and as a region now of emerging importance to the scientific and technological base of the United States, we are anxious to follow the proven patterns of achieving increased productivity and rising standards of living for our citizens by investing ourselves in education in scientific research.

Texas is investing heavily in its universities and educational establishments. As a result, our universities are growing in strength and reputation. We have important contributions to make. But like most universities in our sister States, we cannot achieve our full potential without the assistance that will be provided by the proposed University Research Facilities Revitalization Act of 1985.

Provisions of this act can make an enormous difference. It will reestablish at once our traditional relationships with the Federal agencies sponsoring university research and it will redress the imbalance that has been created during the past decade and a half that has led to the nationwide deterioration and weakening of the university research infrastructure. This bill has the virtue of directness and simplicity. It will be effective and we urge its enactment.

[The prepared statement of Mr. Anderson follows:]

STATEMENT

OF

DUWAYNE M. ANDERSON

ASSOCIATE PROVOST FOR RESEARCH
TEXAS A&M UNIVERSITY

BEFORE THE

SUBCOMMITTEE SCIENCE, RESEARCH AND TECHNOLOGY

HOUSE COMMITTEE OF SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

OCTOBER 22, 1985

My name is Duwayne M. Anderson. I am Associate Provost for Research at Texas A&M University. I appreciate this opportunity to appear before this distinguished Subcommittee of the House on Science, Research and Technology. We in Texas support H.R. 2823, the University Research Facilities Revitalization Act of 1985.

Mr. Chairman, previous testimony before this committee has confirmed the statements made earlier in introducing H.R. 2823. The network of institutions of higher education in the United States is a critical national resource. As a nation we have reaped rich rewards from our investments in education and in scientific research. Our university system is respected throughout the world. It is being emulated in its essential aspects in most developing nations throughout the world. Both the already industrialized nations and the emerging nations of the world today are investing heavily in scientific research. Why? Because they have seen that the technologies that result from the application of research results are an essential factor in elevating living standards and the quality of life in any country that is successful in establishing the necessary foundations.

Consider the trends shown in Table 1 where research expenditures and research personnel in major nations are compared from 1965-1980. Japan has led in terms of growth and research expenditures for the past 15 years with a

COMPOUNDED ANNUAL GROWTH RATE OF 17.3%. JAPAN IS FOLLOWED BY WEST GERMANY WITH A GROWTH RATE OF 13.7%. THE USSR IS NEXT WITH A GROWTH RATE OF 8.4%. DURING THE SAME PERIOD RESEARCH EXPENDITURES IN FRANCE GREW AT THE RATE OF 7.8%. IN THE UNITED STATES RESEARCH EXPENDITURES GREW AT A COMPOUNDED ANNUAL RATE OF 4.4%; IN THE UNITED KINGDOM IT HAS BEEN 3.2%, BARELY ENOUGH TO MAINTAIN HER STRUGGLING ECONOMIC BASE.

INVESTMENTS OF MANPOWER IN RESEARCH DURING THIS PERIOD SHOW SIMILAR TRENDS. THEY HAVE BEEN HIGHEST IN JAPAN AND THE USSR WITH COMPOUNDED ANNUAL GROWTH RATES OF 6.5% AND 6.8% RESPECTIVELY. THE RATE OF GROWTH IN SCIENTIFIC MANPOWER IN WEST GERMANY DURING THIS 15 YEAR PERIOD WAS 4.7% PER YEAR; IN THE UNITED KINGDOM IT WAS 4.2%; IN FRANCE 3.4%. IN CONTRAST, THE GROWTH IN SCIENTIFIC MANPOWER IN THE UNITED STATES DURING THIS PERIOD WAS ABOUT 1.8% PER YEAR.

OF COURSE THE NATIONS WITH THE HIGHEST RATE OF GROWTH STARTED FROM A MUCH SMALLER BASE, BUT THE EMERGENCE OF JAPAN AS A MAJOR ECONOMIC POWER IN WORLD COMMERCE CAN NOW BE SEEN TO BE A DIRECT RESULT OF HER HEAVY INVESTMENT IN RESEARCH.

WE ARE CHALLENGED AND GREATLY CONCERNED TODAY WITH INCREASING ECONOMIC COMPETITION FROM THE PACIFIC BASIN NATIONS WHERE THE GROWING ECONOMIC POWER OF THIS REGION IS SO CLEARLY RELATED TO THE STEADILY RISING EDUCATIONAL LEVELS

OF THEIR POPULATIONS. CONSIDER THESE TRENDS: IN THE YEARS PRECEEDING 1950, FEWER THAN 1% OF INDIVIDUALS ENTERING THE WORK FORCE IN JAPAN HAD A COLLEGE OR UNIVERSITY EDUCATION. BY 1980, 39% OF ALL NEW ENTRIES TO THE LABOR FORCE IN JAPAN HAD COLLEGE OR UNIVERSITY DEGREES. THE PROPORTION OF UNIVERSITY GRADUATES ENTERING THE LABOR FORCE IN JAPAN NOW HAS REACHED A LEVEL HIGHER THAN THAT OF WESTERN EUROPE. IT IS NOW FULLY EQUAL TO THAT OF THE UNITED STATES. SIMILAR TRENDS CAN BE OBSERVED IN CHINA, KOREA AND TAIWAN.

THE RESULTS ARE PRETTY CLEAR. FROM 1950-1980 THE GNP PER CAPITA IN THE UNITED STATES INCREASED FROM SLIGHTLY LESS THAN $2,000 TO APPROXIMATELY $11,000 PER PERSON. DURING THE SAME PERIOD, THE GNP PER CAPITA IN JAPAN ROSE FROM ABOUT $150 PER PERSON TO SLIGHTLY MORE THAN $9,000 PER PERSON. SIMILAR RATES OF INCREASE NOW ARE OCCURRING IN NORTH AND SOUTH KOREA, SINGAPORE, HONG KONG AND TAIWAN. CHINA EMBARKED MOST RECENTLY ON THE SAME STRATEGY FOR GROWTH AND DEVELOPMENT. AS WE IN THE WEST HAVE DONE BEFORE THEM, THE PACIFIC BASIN NATIONS TODAY ARE IMPLEMENTING STRATEGIES FOR GROWTH AND DEVELOPMENT BASED ON SCIENTIFIC AND TECHNOLOGICAL RESEARCH LINKED TO EXPANDING SYSTEMS OF HIGHER EDUCATION. NOTWITHSTANDING THE DIFFICULTIES THIS IS CREATING FOR US, WE WELCOME THIS, FOR IT CONFIRMS OUR OWN DEEP BELIEF IN THE VALUE OF EDUCATION AND OUR OWN PRACTICAL EXPERIENCES IN REAPING THE RICH REWARDS OF SCIENTIFIC RESEARCH THAT IS

RESPONSIBLE FOR THE INCREASES IN OUR STANDARD OF LIVING AND THE QUALITY OF LIFE WE ENJOY.

TODAY WE ARE INVESTING ABOUT 2.7% OF OUR GNP IN RESEARCH AND DEVELOPMENT. ABOUT $110B WILL BE SPENT ON RESEARCH AND DEVELOPMENT THIS YEAR. ABOUT HALF OF THIS IS BEING DISTRIBUTED BY AGENCIES OF THE FEDERAL GOVERNMENT. A LARGE PART WILL BE PROVIDED BY PRIVATE INDUSTRY AND THE REMAINDER WILL COME FROM STATE AND LOCAL GOVERNMENTS. THIS IS A LARGE INVESTMENT. ITS ALLOCATION AMONG RESEARCH BUDGET CATEGORIES NEEDS IMPROVEMENT, HOWEVER.

AS YOU KNOW, MODERN RESEARCH IS PURSUED IN A VARIETY OF INSTITUTIONAL SETTINGS. AFTER SOME EXPERIMENTATION, WE FIND THAT THE MAJORITY OF BASIC RESEARCH STILL IS FOUND IN THE UNIVERSITY SETTING. ABOUT ONE THIRD OF ALL BASIC RESEARCH IS PERFORMED AS A PART OF INDUSTRIAL RESEARCH AND DEVELOPMENT PROGRAMS. INDUSTRIAL LABORATORIES, HOWEVER, PLACE MUCH MORE EMPHASIS ON APPLIED RESEARCH AND TECHNOLOGY OR PRODUCT DEVELOPMENT. THERE IS A SUBSTANTIAL AREA OF OVERLAP OF ACTIVITY, HOWEVER. BECAUSE OF THE IMPORTANCE OF ACHIEVING RAPID TRANSFER OF NEW BASIC DATA AND PRINCIPLES TO PRACTICAL NEW TECHNOLOGIES, THIS AREA OF OVERLAP HAS BEEN IDENTIFIED AS CRITICAL. MUCH EMPHASIS IS NOW BEING PLACED ON IMPROVING THE EFFECTIVENESS OF THE UNIVERSITY/INDUSTRY PARTNERSHIP. TAKING THE BROADEST VIEW, WHAT WE REALLY HAVE BEEN WORKING TOWARD IS AN INTEGRATED PARTNERSHIP BETWEEN THE

UNIVERSITIES, THE PRIVATE AND INDUSTRIAL SECTOR AND FEDERAL AND STATE GOVERNMENT.

THE IMPORTANCE OF IMPROVING THE EFFECTIVENESS OF THIS PARTNERSHIP BY BETTER COORDINATION WAS STRESSED AT AN EARLIER HEARING BY DR. DALE CORSON, CORNELL UNIVERSITY, CHAIRMAN OF THE GOVERNMENT UNIVERSITY/INDUSTRY RESEARCH ROUNDTABLE. IN TEXAS WE HAVE RECOGNIZED THIS AND WE ARE WORKING HARD TO DO OUR PART. WE ARE MAKING GOOD PROGRESS. HOWEVER, WE ARE FACING FORMIDABLE DIFFICULTIES BECAUSE OF INADEQUATE RESEARCH INSTRUMENTATION AND EQUIPMENT. AS IS TRUE IN OTHER STATES, OUR RESEARCH INFRASTRUCTURE IS BADLY IN NEED OF MODERNIZATION AND EXPANSION.

RECALL THAT FOR NEARLY A DECADE BEGINNING IN THE MIDDLE TO LATE 1960S, RESEARCH AND DEVELOPMENT EXPENDITURES REMAINED ROUGHLY AT CONSTANT LEVELS IN INFLATION CORRECTED DOLLARS. DURING THIS PERIOD, THE NUMBERS OF TRAINED SCIENTISTS CONTINUED TO INCREASE. RESEARCH PROGRAM DIRECTORS IN GOVERNMENT AND INDUSTRY WERE FORCED TO MAKE DIFFICULT CHOICES. BY AND LARGE, THE DECISIONS MADE PLACED HIGHEST PRIORITY ON PROVIDING FUNDING FOR PERSONNEL AT THE EXPENSE OF PROVIDING ADEQUATE FUNDS FOR UNIVERSITY RESEARCH EQUIPMENT AND FACILITIES. AS A RESULT, THE NATION'S UNIVERSITY RESEARCH INFRASTRUCTURE HAS BEEN NEGLECTED TO SUCH AN EXTENT THAT NOW IT IS NOT POSSIBLE TO FULLY UTILIZE

ALL THE HIGHLY TRAINED SCIENTISTS AND ENGINEERS THAT WE HAVE PRODUCED IN RECENT YEARS.

THIS IS ESPECIALLY TROUBLING BECAUSE SCIENTIFIC ADVANCES TODAY TO AN EXTRAORDINARY DEGREE ARE PACED BY ACCESS TO SCIENTIFIC INSTRUMENTATION AND EQUIPMENT OF INCREASING SPEED, POWER AND VERSATILITY. AS PREVIOUS TESTIMONY HAS STRESSED, WE PRESENTLY ALL ARE SEVERELY LIMITED BY OBSOLETE, WORN OUT OR INADEQUATE EQUIPMENT AND FACILITIES. IN SPITE OF TEN YEARS OF DETERMINED EFFORT BY OUR STATE LEGISLATURE, WE IN THE UNIVERSITIES OF TEXAS FEEL PARTICULARLY CONSTRAINED AND HANDICAPPED BY OUR INABILITY TO ACQUIRE RESEARCH INSTRUMENTATION AND EQUIPMENT IN THE QUANTITIES AND AT A RATE THAT WILL PROVIDE FOR THE FULL UTILIZATION OF THE ABILITIES OF OUR SCIENTISTS AND ENGINEERS. WE URGENTLY NEED THE ASSISTANCE PROVIDED FOR IN H.R. 2823.

I WISH TO CALL TO YOUR ATTENTION TO ANOTHER CONSEQUENCE OF THE RESTRICTED FUNDING FOR RESEARCH AND DEVELOPMENT THROUGHOUT THE LATE SIXTIES AND EARLY SEVENTIES. WE EXPERIENCED THE CLASSIC "TRAGEDY OF THE COMMONS". AS PROGRAM DIRECTORS ATTEMPTED TO GET THE VERY UTMOST FROM THE FUNDS AT THEIR DISPOSAL, A SHIFT IN ATTITUDES OCCURRED. PROGRAM DIRECTORS AND CONTRACTING OFFICERS MORE AND MORE CAME TO REGARD FEDERAL RESEARCH PROGRAMS IN THE UNIVERSITIES AS SERVICES TO BE PROCURED. A GENERAL "PROCUREMENT

POSTURE" NOW CHARACTERIZES RELATIONSHIPS BETWEEN UNIVERSITIES AND THE FEDERAL AND STATE GOVERNMENTS. THE EFFECTS HAVE BEEN PERNICIOUS. THEY HAVE BADLY DAMAGED THE UNIVERSITY FEDERAL AND STATE GOVERNMENT PARTNERSHIP. IT IS IN THE INTERESTS OF EVERYONE THAT THIS BE REMEDIED AT ONCE. H.R. 2823 WILL RESTORE THE EARLIER MORE DESIRABLE CHARACTERISTICS OF OUR PARTNERSHIP, A PARTNERSHIP IN WHICH GOVERNMENT REGARDED ITS DISPERSEMENTS TO UNIVERSITIES RESEARCH PROGRAMS AS INVESTMENTS IN THE FUTURE. THIS IS THE CHARACTERISTIC THAT HAS TYPIFIED OUR RELATIONSHIP IN ITS MOST EFFECTIVE AND PRODUCTIVE PERIODS.

THE CITIZENS AND THE LEADERS OF TEXAS ARE CONCERNED TODAY WITH THE NEED TO DIVERSIFY THE ECONOMIC STRUCTURE OF OUR STATE. AS A REGION OF EMERGING IMPORTANCE TO THE SCIENTIFIC AND TECHNOLOGICAL BASE OF THE UNITED STATES WE ALSO ARE ANXIOUS TO FOLLOW PROVEN PATTERNS OF ACHIEVING INCREASED PRODUCTIVITY, RISING STANDARDS OF LIVING, AND INCREASED QUALITY OF LIFE THAT FOLLOW INVESTMENTS IN EDUCATION AND SCIENTIFIC RESEARCH.

TEXAS IS INVESTING HEAVILY IN ITS UNIVERSITIES AND EDUCATIONAL ESTABLISHMENTS. AS A RESULT, OUR UNIVERSITIES ARE RAPIDLY GROWING IN STRENGTH AND REPUTATION. WE HAVE IMPORTANT CONTRIBUTIONS TO MAKE. LIKE MOST UNIVERSITIES IN OUR SISTER STATES, HOWEVER, WE CANNOT ACHIEVE OUR FULL POTENTIAL WITHOUT THE ASSISTANCE THAT WILL BE PROVIDED BY

THE PROPOSED UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985. THE PROVISIONS OF THIS ACT CAN MAKE AN ENORMOUS DIFFERENCE. IT WILL REESTABLISH, AT ONCE, OUR TRADITIONAL RELATIONSHIPS WITH THE FEDERAL AGENCIES SPONSORING UNIVERSITY RESEARCH AND IT WILL REDRESS THE IMBALANCE THAT HAS BEEN CREATED DURING THE PAST DECADE AND A HALF THAT HAS LED TO THE NATIONWIDE DETERIORATION AND WEAKENING OF THE UNIVERSITY RESEARCH INFRASTRUCTURE. THIS BILL HAS THE VIRTUE OF DIRECTNESS AND SIMPLICITY. IT WILL BE EFFECTIVE. WE APPLAUD IT AND URGE ITS ENACTMENT.

Table 1. Research Expenditures in Major Countries
($ billion)

	Japan	West Germany	USSR	France	United States	United Kingdom
1965	1.6	2.8	10.9	2.9	28.6	3.6
1970	4.7	5.7	18.4	3.9	36.9	3.7
1975	10.4	9.1	27.2	7.2	41.2	5.6
1980	18.5	19.4	28.9	8.9	54.8	5.8
Growth*	17.3%	13.7%	8.4%	7.8%	4.4%	3.2%

Research Personnel in Major Countries
(Thousand)

	Japan	USSR	West Germany	United Kingdom	France	United States
1965	117.6	664.6 (1967)	61.6	56.6	44.0	494.5
1970	172.0	927.7	78.4	54.7	57.3	540.9
1975	255.2	1,223.4	94.1	78.8	62.0	533.1
1980	302.6	1,373.3 (1978)	122.0	104.4	72.9	643.5
Growth*	6.5%	6.8%	4.7%	4.2%	3.4%	1.8%

*Compounded Annual Growth Rate
Source: *The Strategy of Japanese Business*, James C. Abegglen, Ballinger Publ. Co., Cambridge, MA, 1984.

Mr. WALGREN. Thank you, Dr. Anderson, very much.

Dr. Sissom.

Mr. SISSOM. Thank you very much, Mr. Chairman. I appreciate your inviting me here today to discuss H.R. 2823. I am pleased to see the agencies joining in the discussions which have been taking place, and which will take place. A cooperative effort by all Federal agencies involved in our country's research enterprise is the only way to effectively solve the university facilities problem, in my opinion.

The institutional examples described in my testimony are drawn primarily from my own institution—Tennessee Technological University.

I speak, however, from a much broader perspective as chairman of the National Engineering Deans Council of the American Society for Engineering Education. Our council represents the approximately 300 engineering schools in the country—all at the table here today included. Together we enroll over 400,000 engineering students, with programs ranging from less than 100 students to over 10,000.

I also offer my comments today on behalf of the National Society of Professional Engineers. NSPE is a nontechnical professional society, representing over 75,000 professional engineers of all disciplines nationwide.

My fellow NSPE colleagues are especially concerned that their future employees and associates are learning primary engineering skills on equipment and in facilities that lag one to two generations behind that which they will encounter when they begin professional practice.

In addition, although I don't represent these organizations today, I bring to this forum the fruits of my personal involvement in my own discipline and in the accrediting agency for our schools.

I currently serve as senior vice president for Education of the American Society of Mechanical Engineers. In that role I have frequently bemoaned the 115-percent increase in engineering enrollments over the past decade which has far outstripped a less than 15 percent increase in faculty size.

I also serve on the board of directors and as an officer of the accreditation board for engineering and technology. There I have watched accreditation terms granted to schools become shorter and shorter due to the deterioration of facilities and equipment and to a critical shortage of faculty.

Today, let me on behalf on my engineering colleagues, applaud Congressman Fuqua and his colleagues for their leadership in tackling the cancerous facilities problem plaguing our schools. Neglect and misdirected priorities in many quarters have brought American academic laboratories to a sad state of disrepair and obsolescence. Indeed, in many university engineering laboratories, students are being forced to learn on equipment older than they are.

Strong national security, a better standard of living, and world technological leadership are obvious benefits to be gained from a healthy U.S. engineering enterprise. As this country becomes increasingly technology-oriented, our engineering schools will be called upon as never before to turn out the innovative people and research that will keep us on top.

Paradoxically, pressure to turn out the quality and quantity of well-educated engineers needed by industry has already begun to threaten the ability of our schools to provide the finest education available. Overcrowded classrooms, obsolete and overworked facilities and equipment, and a loss of graduate students to industry all present special challenges.

More students require more space, or at least more efficient space—a commodity our aging buildings and labs simply cannot supply.

The best data available on engineering research laboratory space are from the American Society for Engineering Education's "1983-84 Planning Factors in Engineering Education" study. Compatible data are available for a 7 year period—from 1977 to 1984. During that 7-year period, there was an average decrease of 8.6 percent in laboratory space per graduate student. Thus, not only is academic space deteriorating in quality, but in quantity as well.

I might note that the dean of engineering at the University of Massachusetts, Dr. James John, is nearing completion of a study of equipment and space needs in engineering schools under auspices of the National Association of State Universities and Land-Grant Colleges. Based on his research for the study, Dr. John asserts that modern, up-to-date space may well be the most important issue facing engineering education in the decade to come.

The survey data gathered from 50 participating NASULGC schools shows a need for 1.79 million square feet of modern instructional and laboratory space to bring below-the-line schools up to the current square-foot-per-student average.

Dr. John further notes that this national average is far from ideal. If you multiply that 1.79 million square feet by $100 to $200 per square foot required for new construction costs, that yields a minimum of $180 to $360 million just in "catch-up" building for our engineering schools.

A 1984 survey of a sample of NSF investigators found that 60 percent reported having lost some time in the previous year to facilities-related failures. With a documented 8.5 percent shortage of qualified engineering faculty facing us, we can't afford to lose any more of our best and brightest graduate students or faculty to industry because of poor working conditions in our schools.

Productivity and the quality of research are also affected by the poor shape of our facilities. Let me give you just one example from my own institution. About 15 years ago, I was thrilled to learn that about 20,000 square feet of space was to be made available for special purpose engineering laboratories under the stands of our football stadium. But there were leaks and it needed air conditioning and humidity control to protect delicate instrumentation. Today that same space still leaks and still needs air conditioning and humidity control. The university simply has not been able to divert sufficient funds to cure these problems.

As a result, we have high failure rates in instruments and our research data is sometimes questionable. In some circumstances, experiments have to be run a number of times to assure the validity of results, hardly an efficient use of equipment and time.

I wish to point out, also, that few engineering laboratories are restricted to bench tests. Floor space, head room and services—such as water, air, gas, power, exhausts, and so forth—vary widely from project to project. One engineering laboratory may need to be acoustically isolated, an adjacent lab may require radio frequency shielding, while yet another one may call for a four-story constant-head tank for a hydraulics study. These are built-in needs which must be incorporated into the design of the structure and cannot be easily changed.

Equally important, an effect that poor facilities has on engineering research is one that is not visible and not easily evaluated. I speak of the specific research problems that are not being addressed because of limitations in facilities.

What avenues of inquiry are not being pursued because we simply cannot conduct the research?

This may be the most difficult problem of all to gauge because the more creative the ideas, the less predictable they would be and thus, that much less noticeable their absence would be in the near term.

One thing that I know for sure is that we cannot afford as a Nation is to frustrate and stifle the very creativity that has made us the technological leader that we are.

I want to applaud particularly the provision in H.R. 2823 calling for periodic assessments of research facilities needs in science and engineering by the National Science Foundation. The collection of relevant data over the long-term is absolutely vital to understanding the condition of our research and teaching infrastructure. With such information to guide us, we can leverage our resources more cost effectively and efficiently in the longrun. I already have in mind an example at my own school which would be of interest to the NSF survey. Recently we have acquired $25 million over a 5-year period, a third from extramural sources, for three research centers, but adequate space is simply not available to house them.

Another example is of key state-of-the-art computer-aided-manufacturing equipment currently being housed in an unair-conditioned, poorly lighted laboratory while we frantically seek ways of improving its functionality. The NSF assessment will prove invaluable in documenting these and the many other frustrating instances that abound in our Nation's universities.

I would recommend two important additions to NSF's data-gathering role under this bill: the collection of information on both facilities operating and maintenance expenses. Buildings and the labs in them require money to be operated and kept in working order. These are very real expenses that too often are not explicitly recognized in funding scenarios.

I think that we would learn a great deal by systematically gathering data on these vital expenditures. I encourage including this role in the NSF's charge.

More broadly, I would like to see operating and maintenance costs of facilities addressed throughout the bill. While I recognize that the general thrust of the legislation is toward replacement and modernization of buildings, I must point out that the lack of funds for proper maintenance and operation has accelerated our facilities' obsolescence.

I recommend the addition of a permissive clause which would allow, but not require, a small percentage of the facilities funds available under each award to be applied to maintenance and operation. The number need not be as high as the 10 to 15 percent usually used as a rule of thumb by universities from their education and general budgets to pay for maintenance and operation, but some recognition of these costs would be an important addition to the impact of H.R. 2823.

I am delighted that this committee has taken the bold step of considering such a longterm improvement program. If the Federal Government is to make this type of investment in our academic physical plant it should be as flexible and responsive an initiative as possible.

For those schools that have invested heavily in facilities, but now cannot maintain or properly equip them, it would be beneficial if this bill could respond to those needs. Especially in engineering, where over 66 percent of our recently graduated engineers enter professional practice with a B.S. degree only, the bulk of engineering schools are not focused on Ph.D. level research, and, therefore, have not benefited from Federal equipment programs.

Further, for many institutions it is easier to obtain support for facilities from alumni and other extramural sources than it is for equipment, as buildings offer much greater potential for recognition. However, without funds for equipment and maintenance, there is little incentive to launch a building campaign.

Schools who have secured support for facilities should not be penalized and could be offered an opportunity to complete their infrastructure improvements through this bill. To accomplish this, I suggest adding a provision that would allow schools that have invested a certain dollar amount or budget percentage, over a limited timeframe, to be eligible for laboratory equipment awards for their new buildings.

Allowing universities flexibility in allocating resources for facilities improvements will maximize the usefulness of the program. Buildings and equipment are interdependent and cannot really be considered in isolation of each other.

With respect to the 10 percent formula set out in H.R. 2823 as a mechanism to insure ongoing investment by the 6 missions agencies for the 10-year period of the program, I have a few observations.

First, I cannot help but draw an analogy between our current academic facilities problem and our country's smokestack industries, some of which failed to invest at critical junctures. Failure to bring our laboratories and research facilities up to date will just as surely bring on their demise. One look at our steel and rubber industries illustrates the magnitude of the degradation which awaits research if we do not act.

Thus, I take issue with those whose abiding concern is the potentially deleterious effect of this bill on the research base. The research base will not matter very much if we don't have the facilities in which to conduct the research.

I do recommend, however, that great care be given to "spinning out" the formula as written under various budgetary scenarios to assess accurately what the potential impact may be. Fine-tuning of the formula is warranted to prevent wide fluctuations in funding under different budget timelines.

Consideration may be due also to setting a maximum ceiling, as I believe Mr. Baker said earlier, of annual facilities funding under the entire program, as well as the minimum prescribed in the bill, in order to avoid unintended interpretation of the original intent of the measure. Setting such parameters may help to set at ease concerns about the impact of the initiative on the research base.

Another observation I would offer addresses the process by which the competitive grants are awarded. While I recognize the need to give the six mission agencies real flexibility to fit this program into their modes of doing business, I think H.R. 2823 provides a much needed opportunity to address more explicitly the continuing value of peer review.

I think it might be very useful to stress the importance of peer review and the competitive grant system as important mechanisms for assuring quality. We have heard this before and we are familiar with the so-called end runs for facilities funding which recently made it through congressional appropriations.

On the topic of the 15-percent set-aside for institutions which currently receive less than $2 million in Federal support, I'd like to bring in the factor of institutional size. The ASEE study, which I mentioned a few moments ago, reveals that our smaller engineering schools—many of which are predominantly undergraduate institutions—have lost more space per student than their larger counterparts over the last several years.

I would further point out that 50 percent of all research conducted at engineering schools is handled by institutions which turn out only 22 percent of our baccalaureate degrees. One-half or more of our engineering B.S. degree-holders are receiving their only formal training at institutions which do not conduct large-scale research programs. Better than two-thirds of our B.S. graduates go straight into industry with no higher degree. Although these statistics are not sufficiently detailed to base definitive action, they do suggest that the 15-percent set-aside may prove inadequate to the needs of an important portion of our engineering schools. The NSF assessment will prove valuable for gathering good statistics on this issue.

The matching requirement of H.R. 2823 will not only effectively leverage Federal dollars, but it will attract additional friends to universities as a variety of publics are cultivated for matching funds. I would sound one cautionary note, however. Many institutions are approaching the limit of their matching fund capability because so many new initiatives, at both the State and Federal levels, require heavy matching. As a result, some institutions cannot afford to pursue programs which require significant matching.

In closing, I'd like to point out that no single initiative will solve the facilities problem. Serious thought needs to be given to readjusting indirect cost rates in grants to reflect actual lifespans of buildings and equipment. This should not and will not replace the need for a major facilities effort, which should certainly be investigated simultaneously with other approaches. No idea, no approach to tackling our urgent facilities problem should be discarded without the kind of broad scale, national discussion that we are taking part in today on this fine effort.

Thank you very much. I would be glad to answer any questions at the appropriate time.

[The prepared statement of Mr. Sissom follows:]

TESTIMONY OF

DR. LEIGHTON E. SISSON, P.E.

CHAIRMAN, ENGINEERING DEANS COUNCIL

ON BEHALF OF THE

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

AND THE

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

ON HR 2823

THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF OF 1985

Subcommittee on Science, Research and Technology
U.S. House of Representatives

October 22, 1985

Mr. Chairman and members of the Subcommittee:

I'd like to thank you for inviting me here today to discuss H.R. 2823, the "University Research Facilities Revitalization Act of 1985". The institutional examples described in my testimony are drawn primarily from my own institution -- Tennessee Technological University. I speak, however, from a much broader perspective as Chairman of the national Engineering Deans Council of the American Society for Engineering Education (ASEE). Our Council represents the approximately 300 engineering schools in the country. Together we enroll over 400,000 engineering students, with programs ranging from less than a hundred students to over 10,000.

I also offer my remarks today on behalf of the National Society of Professional Engineers (NSPE). NSPE is a non-technical professional society, representing over 75,000 professional engineers of all disciplines nationwide. My fellow NSPE colleagues working in industry, government, private practice, and construction are especially concerned that their future employees and associates are learning primary engineering skills on equipment and in facilities that lag one to two generations behind that which they will encounter when they begin professional practice.

In addition, although I don't represent these organizations today, I bring to this forum the fruits of my personal involvement in both my own discipline and in the accrediting agency for our schools. I currently serve as Senior Vice President for Education of the American Society of Mechanical Engineers (ASME). In that role I have frequently bemoaned the 115 percent increase in engineering enrollments over the past decade which has far outstripped a less-than 15 percent increase in faculty size. I also serve on the Board of Directors and as an officer of the Accreditation Board for Engineering and Technology (ABET). There I have watched accreditation teams granted to schools become shorter and shorter due to the deterioration of facilities and equipment and to a critical shortage of faculty.

Today, let me on behalf of my engineering colleagues applaud Congressman Fuqua for his leadership in tackling the cancerous facilities problem plaguing our schools. Neglect and misdirected priorities in many quarters have brought American academic laboratories to a sad state of disrepair and obsolescence. Indeed, in most university engineering laboratories, students are being forced to learn on equipment older than they are. Attention to these problems at all levels, by all of the stakeholders in the system, is vital if we are to remain world leaders in education and research.

Strong national security, a better standard of living, and world technological leadership are obvious benefits to be gained from a healthy U.S. engineering enterprise. As this country becomes increasingly technology-oriented, our engineering schools will be called upon as never before to turn out the innovative people and research that will keep us on top. Paradoxically, pressure to turn out the quality and quantity of well-educated engineers needed by industry has already begun to threaten the ability of our schools to provide the finest education available. Overcrowded classrooms, obsolete and overworked facilities and equipment, and the loss of graduate students -- potential first-rate faculty -- to industry all present special challenges.

Dr. Linda Wilson, Vice President for Research at the University of Michigan, in a recent paper on facilities underscores the links among facilities, our engineering schools and our economy:

> "Deteriorating physical plants and obsolete equipment have already rendered many programs, especially in engineering, far behind current professional practice. To the extent universities lag rather than lead in state-of-the-art practice, they do not meet the needs of industry and government for highly-trained personnel. What has been a significant source of innovation is being extinguished." (1984)

Only 10 years ago, with a mere five percent of the world's population, the U.S. generated 75 percent of the world's technology. Today the U.S. share has declined to 50 percent. From 1962 to 1980, Japan's share of world exports of high technology products increased from 4 to 14 percent. Clearly, action needs to be taken to assure that our engineering students receive the finest education available if we are to prevent further declines in U.S. competitiveness.

What are the special effects that the poor condition of academic facilities has on the engineering education environment? One profoundly-felt irony is that while skyrocketing engineering enrollments over the last decade have demanded expansion and renewal of the academic engineering environment, facilities have deteriorated as schools battle to balance scarce resources with growing needs. More students require more space, or at least more efficient space -- a commodity our aging buildings and labs simply cannot supply. The best data available on engineering research laboratory space are from the American Society for Engineering Education's "1983-84 Planning Factors in Engineering Education" study. Compatible data are to be had for a seven year period -- from 1977 to 1984. During that seven-year period, there was an average decrease of 8.6% in laboratory space per graduate student. Thus, not only is academic space deteriorating in quality, but in quantity as well.

I might note here that the Dean of Engineering at the University of Massachusetts, Dr. James John, is nearing completion of a study of equipment and space needs in engineering schools under the auspices of the National Association of State Universities and Land-Grant Colleges. Dr. John will present his findings next month at NASULGC's meeting here in Washington, D.C. Based on his research for the study John asserts that modern, up-to-date space may well be the most important issue facing engineering education in the decade to come. The survey data gathered from 50 participating NASULGC schools shows a need for 1.79 million square feet of modern instructional and laboratory space to bring below-the-line schools up to the current square-foot-per-student average. John further notes that this national average is far from ideal. Multiplying that 1.79 million figure by $100 to $200 per square foot in new construction costs yields a bare minimum of approximately $180 to $360 million just in "catch-up" building for our engineering schools.

Other effects of deteriorating facilities are making themselves felt as well. The appeal of the academic research environment to faculty and to potential graduate students is negatively impacted by poor facilities. A 1984 survey of a sample of NSF investigators found that 60% reported having lost some time in the previous year due to facilities-related failures. With a documented 8.5% shortage of qualified engineering faculty facing us, we can't afford to lose any more of our best and brightest graduate students or faculty to industry because of poor working conditions in our schools.

Productivity and the quality of research are also affected by the poor shape of our facilities. Let me give you just one example from my own institution. About 15 years ago I was thrilled to learn that about 20,000 square feet of space was to be made available for special purpose engineering laboratories (e.g. anechoic and reverberation chambers for acoustical testing) under the stands of our football stadium. But there were leaks and it needed air conditioning and humidity control to protect delicate instrumentation. Today that same space still leaks and still needs air conditioning and humidity control. The University simply has not been able to divert sufficient funds to cure these problems. As a result, we have high failure rates in instruments and our research data can sometimes be questionable. In such circumstances, experiments may need to be conducted several times to assure the validity of results, hardly an efficient use of time and equipment. Clearly, then, the design of facilities themselves can affect the caliber and sensitivity of research that can be undertaken. That universities conduct about 12% of the nation's research and development, and half of its fundamental research, can only more dramatically underscore the urgency of our facilities problem.

I wish to point out, too, that space for engineering laboratories must be more flexible than that dedicated to science programs. Few engineering laboratories are restricted to bench tests. Floor space, head room and services -- water, air, gas, power, exhausts, etc. -- very widely from project to project. One engineering laboratory may need to be acoustically isolated, an adjacent lab may require radio-frequency (RF) shielding, while yet another may call for a four-story constant-head tank for a hydraulics study. These are "built-in" needs which must be incorporated into the design of the structure and cannot be easily changed.

Finally, an effect that poor facilities have on engineering research is one that is not visible and not easily evaluated. I speak of the specific research problems that are not being addressed because of limitations in facilities. What avenues of inquiry are not being pursued because we simply cannot conduct the research? This may be the most difficult problem of all to gauge because the more creative the ideas, the less predictable they would be and thus that much less noticeable their absence would be in the near term. One thing that I know that we cannot afford as a nation is to frustrate and stifle the very creativity that has made us the technological leader that we are.

The importance of modern, vital facilities to quality engineering research and education cannot be underestimated. My colleague, Dr. Donald D. Glower, P.E., Dean of Engineering at Ohio State University, has prepared an outstanding summary of the role of laboratory instruction in engineering education. I commend his statement to your attention, and have attached it to my testimony for the record.

Let me turn now to H.R. 2823, the legislation before us today. I can't adequately express how heartened my colleagues and I are to see a bill like this on the table for discussion. While I have a number of comments and suggestions to offer, I must say that I am delighted to see the facilities issue receiving much-needed national level attention.

First, I want to applaud particularly the provision in H.R. 2823 calling for periodic assessments of research facilities needs in science and engineering by the National Science Foundation. The collection of relevant data over the long-term is absolutely vital to understanding the condition of our research and teaching infrastructure. With such information to guide us, we can leverage our resources more cost-effectively and efficiently in the long run. I already have in mind an example at my own school which would be of interest to the NSF survey. Recently we have acquired $25 million over a five year period, a third from extramural sources, for three research centers, but adequate space is simply not available to house them. Another example is of key state-of-the-art computer-aided-manufacturing (CAM) currently being housed in an un-air-conditioned, poorly lighted laboratory while we frantically seek ways of improving its functionality. The NSF assessment will prove invaluable in documenting these and the many other frustrating instances that abound in our nation's universities.

I would recommend two important additions to NSF's data-gathering role under this bill -- the collection of information on both facilities operating and maintenance expenses. Buildings and the labs in them require money to be operated and kept in working order. These are very real expenses that too often are not explicitly recognized in funding scenarios. I think that we would learn a great deal by systematically gathering data on these vital expenditures and I encourage including this role in the NSF's charge under H.R. 2823.

More broadly, I would like to see operating and maintenance costs of facilities addressed throughout the bill. While I recognize that the general thrust of the legislation is toward replacement and modernization of buildings, I must point out that the lack of funds for proper maintenance and operation has accelerated our facilities' obsolescence. I recommend the addition of a permissive clause which would allow, but not require, a small percentage of the facilities funds available under each award to be applied to maintenance and operation. The number need not be as high as the 10-15% used as a rule-of-thumb by universities from their education and general budgets to pay for maintenance and operation, but some recognition of these costs would be an important addition to the impact of H.R. 2823. I should also add that ABET, the accrediting agency for our engineering schools has just instituted a new criterion which will require formal attention to these issues and ensure that universities better identify their continuing facilities needs:

> "Each curriculum shall have a carefully constructed and functioning plan for the continued replacement, modernization, maintenance, and support of laboratory equipment and related facilities."

As has been pointed out, our university infrastructure is in desperate need of assistance. I am delighted that this Committee has taken the bold step of considering such a long-term improvement program. If the Federal government is to make this type of investment in our academic physical plant, it should be as flexible and reponsive an initiative as possible. For those schools that have invested heavily in facilities, but now cannot maintain or properly equip them, it would be beneficial if this bill could respond to those needs. Especially in engineering, where over 66% of our recently graduated engineers enter professional practice with a BS degree only, the bulk of engineering schools are not focused on PhD level research, and therefore have not benefitted from Federal equipment programs. Further, for many institutions it is easier to obtain support for facilities from alumni and other extramural sources than it is for equipment, as buildings offer much greater potential for recognition. However, without funds for equipment and maintenance, there is little incentive to launch a building campaign. Schools who have secured support for facilities should not be penalized, and could be offered an opportunity to complete their infrastructure improvements through this bill. To accomplish this, I suggest adding a provision that would allow schools that have invested a certain dollar amount or budget percentage, over a limited time frame, to be eligible for laboratory equipment awards for their new buildings.

Certainly, allowing universities flexibility in allocating resources for facilities improvements will maximize the usefulness of the program. Buildings and equipment are interdependent, and really cannot be considered in isolation of each other.

With respect to the "10 percent formula" set out in H.R. 2823 as a mechanism to insure ongoing investment by the six mission agencies for the 10-year period of the program, I have a few observations. First, I cannot help but draw an analogy between our current academic facilities problem and our country's smokestack industries, some of which failed to invest at critical junctures. Failure to bring our laboratories and research facilities up to date will just as surely bring on their demise. One look at our steel and rubber industries illustrates the magnitude of the degradation which awaits research if we do not act. Thus, I take issue with those whose abiding concern is the potentially deleterious effect of this bill on the research base. The research base will not matter very much if we don't have the facilities in which to conduct the research. I do recommend, however, that great care be given to "spinning out" the formula as written under various budgetary scenarios to assess accurately what the potential impact may be. Fine-tuning of the current formula is warranted to prevent wide fluctuations in funding under different budget timelines. Consideration may be due also to setting a "maximum" ceiling of annual facilities funding under the entire program, as well as the minimum prescribed in the bill, in order to avoid unintended interpretation of the original intent of the measure. Setting such parameters may help to set at ease concerns about the impact of the initiative on the research base.

Another observation I would offer addresses the process by which the competitive grants are awarded. While I recognize the need to give the six mission agencies real flexibility to "fit" this program into their modes of doing business, I think H.R. 2823 provides a much-needed opportunity to address more explicitly the continuing value of peer review. I think it might be very useful to stress the importance of peer review and the competitive grant system as important mechanisms for assuring QUALITY. We are all well aware of the so-called "end runs" for facilities funding made recently through the Congressional appropriations process by certain schools. The most valuable lessons to be learned from that unconventional approach are two: first, that such methods signify the frustrations of academe with the mounting facilities problem, and second, that the objective of quality in academic research is not well-served by appealing only to the political process.

On the topic of the 15% set-aside for institutions which currently receive less than $2 million in federal R&D support, I'd like to bring in the factor of institutional size. The ASEE study which I mentioned a moment ago reveals that our smaller engineering schools -- many of which are predominantly undergraduate instititutions -- have lost more space per student than their larger counterparts over the last several years. I would further point out that 50% of all research conducted at engineering schools is handled by institutions which turn out only 22% of our engineering B.S. degrees. One-half or more of our engineering B.S. degree-holders are receiving their only formal training at institutions which do not conduct large-scale research programs. Better than two-thirds of our B.S. graduates go straight into industry with no higher degree. Although these statistics are not sufficiently detailed upon which to base definitive action, they do suggest that the 15% set-aside may prove inadequate to the needs of an important portion of our engineering schools. The NSF assessment will prove valuable for gathering good statistics on this issue.

The matching requirement of H.R. 2823 will not only effectively leverage federal dollars, but will attract additional friends to universities as a variety of publics are cultivated for matching funds. I would sound one cautionary note, however. Many institutions are approaching the limit of their matching fuhd capability because so many new initiatives, at both the state and federal level, require heavy matching. As a result, some institutions cannot afford to pursue programs that require significant matching. At the same time, the corporate community is being deluged with requests, many of which are for similar programs. Difficult decisions must be made by our industrial partners, who may not always be guaranteed a return on their investment in the near term. To assist these companies in their efforts to support academic research, it would be helpful if OSTP or another federal office coordinated all matching grant proposals and prepared a directory. This would allow companies to see where a particular program fits in, and would offer schools a more informed way to pursue corporate funds.

In closing I'd like to point out that no single initiative will solve the facilities problem. Serious thought needs to be given to readjusting indirect cost rates in grants to reflect actual lifespans of buildings and equipment. This should not and will not replace the need for a major facilities effort, but should certainly be investigated simultaneously with other approaches. Some are suggesting a Salliemae approach to facilities funding. This also may bear real fruit and I urge thorough discussions on the concept. No idea, no approach to tackling our urgent facilities problem should be discarded without the kind of broad, national discussion that we are taking part in today on Mr. Fuqua's fine effort, H.R. 2823.

Thank you. I would be delighted to try to answer any questions.

By Donald G. Glower, P.E., Dean of Engineering, Ohio State University

ENGINEERING EDUCATION: THE ROLE OF LABORATORY INSTRUCTION

Laboratory instruction is as vital in engineering education as is instruction in theory and concepts. This statement is such a truism that it is necessary to add that indepth student comprehension is impossible without a balance of theory and experiment in the academic program. The technology transfer from the faculty to the student is most efficient when the basic laws of nature (science) and the current technology (application of the engineering principles) are presented as theory and then verified through "hands-on" experience in the laboratory. This reinforcing and the building of student's confidence that the theory is valid is an integral part of the student's educational experience. Moreover, as students become proficient in applying the principles of engineering and current technology, they gain the ability to adapt new technologies for the solution of society's problems in the future.

More specifically, the observations of Dr. Ernest O. Doebelin, an outstanding Professor of Mechanical Engineering at The Ohio State University, are as follows:

> In general, laboratory studies are a vital part of engineering education for two major reasons:
>
> 1. A laboratory is a powerful teaching aid wherein one can achieve educational goals unattainable by other means.
> 2. Since engineering practice contains a large component of experimental work, engineering education must contain a similar emphasis.
>
> The laboratory is an important teaching aid. A properly-designed laboratory experience provides the following vital features in a unique way:
>
> 1. Motivation. Students want to be involved with real machines and systems. When they are, they get more interested in all their courses and study harder.
> 2. Development of Judgment/Intuition. Hands-on lab experience gradually develops a "gut-feeling" for equipment behavior which is vital for creative design and invention.
> 3. Confidence. Since all theories are only approximations to reality, one must observe in the lab how actual machines really operate to appreciate when theory works well, becomes marginal, or fails entirely.
> 4. Teamwork/Leadership. Most theory courses are "individual effort". Most lab courses involve groups of two to eight students who must organize themselves and work together toward a common goal. A student group leader may be elected/appointed and has the opportunity to develop leadership skills.

5. Written/Oral Communication. Engineers are often castigated for poor communication skills. In theory courses, routine homework gives little opportunity to develop writing skills. Lab reports in lab courses emphasize techniques of organizing and presenting written information in the most effective manner. Oral presentations, such as progress reports on long projects, serve a similar function for verbal communication.

6. Cooperation with Engineering-Aide Personnel. Students get experience in working with machine-shop workers, electronics technicians, repairmen, etc.

Laboratory methods in engineering practice provide for the solution of problems arising in the design, manufacture, and operation of engineering products and services. These problem solutions can be accomplished in only two fundamental ways:

1. Theoretical Methods

2. Laboratory Experimentation (Empirical Methods)

Most engineering projects involve a mix of the two approaches. Engineers trained in only one of these viewpoints will be unable to correctly decide on the proper blend of theory and lab work which is optimal for a given study, thus wasting valuable time and resources and achieving marginal results. Computer modeling has made theoretical approaches feasible for a wider range of problems than in the past, but extensive laboratory work is still necessary and probably always will be. In fact, projects at the forefront of technology often are almost entirely experimental, since adequate theory has not yet been developed. Since the practice of engineering involves a significant component of experimental work. Engineering education must provide effective training in this area.

What kinds of functions are performed in engineering laboratories in industry? They can be categorized as follows:

1. Measurement of Properties of Materials. Theoretical physics is still largely unable to predict accurately the properties of engineering materials, thus all such properties must be obtained by experiment. These properties determine, for instance, whether the springs in your car will break when you strike a chuck hole.

2. Testing and Improving New Theories. While computer-based theoretical models are increasingly used in engineering, they are never accepted in critical applications (such as life-or-death safety considerations) without carefully checking them by lab testing. Such lab testing also reveals the faults in the theory and gives guidance for theory improvement.

3. Developing Reliable, Quality Products. David Packard of Hewlett-Packard Corporation has stated his company's product development philosophy as "... Reliability cannot be achieved by formula or analysis... There is only one road to reliability.

Build it, test it, and fix the things that go wrong. Repeat the process until the desired reliability is achieved." (Hewlett-Packard Journal, June 1985, page 5).

4. Determining Performance Criteria for Machines and Processes. While engineers estimate performance criteria theoretically at the design stage, testing of the actual machine, once built, is always used to document actual performance for verification of compliance with legal contracts, government rules, etc.

5. Developing Empirical Design Relations When No Adequate Theory is Available. While engineers prefer theoretical methods for their efficiency and economy, when no adequate theory is possible, design must still proceed, and experimental approached allow this in areas, such as human factors, where a theoretical approach has little chance of success.

The above observations of Professor Doebelin are the result of many years of teaching. He has received numerous awards for excellence in teaching. His voice carries great weight at OSU as well as nationally due to his textbooks which are widely adopted across the world.

This emphasis on laboratory instruction is not without parallels in other professional disciplines. In the last twenty years, law schools have placed increasing reliance on clinical programs designed to give the student hands-on experience in courtroom proceedings, settlement negotiations and administrative hearings. These programs attempt to institutionalize and supplement part-time and summer legal employment which prospective employers often consider necessary for successful associates and partners. Likewise, it is difficult to imagine the state of American medical education and research if students did not have access to the great teaching hospitals of the country. Students see firsthand how patients repond to specific treatments and in the process gain the confidence necessary to prescribe treatments for fellow human beings. The "gut-feeling" mentioned by Professor Doebelin is most helpful to practicing attorneys and medical doctors. The analogy fails only in the sense that the enormous costs for maintaining these legal and medical laboratories are only in small part assigned to the educational system which uses them.

There are, of course, areas where educational costs include an adequate exposure to both theory and practice. University-trained artists, musicians and dancers generally have ample opportunities to create using university facilities. Similarly, students of journalism avail themselves of university resources to produce often substantial media products. In no case, however, does the cost of purchasing and maintaining the necessary equipment equal the formidable sums a university must invest if it wishes to offer a first-rate engineering curriculum.

Technology is a term frequently associated with complex machines or devices, those objects which save labor, multiply power, and increase mobility and communications. But in reality, "high tech" machines or devices are only the dynamic or forefront part of technology. The static part of technology includes the so-called infrastructure of our civilization: water supplies and other utilities; transportation including bridges, highways, railroads, etc.; and shelters which include private homes as well as offices and other "artistic creations". The human side of technology development requires hands-on experience in laboratories which are designed to build a level of creative skill for applying technology to different situations. The level of creativity applied by engineers toward the solution of specific problems depends greatly upon the depth of understanding they possess of the engineering and technology which must be applied. This depth of understanding comes from instruction in theory and instruction through laboratory experience. Both are required in an engineer's education.

Technology and engineering are inseparable terms in that the engineering component touches all of technology. Engineering includes two major components: Engineering Science and Engineering Art. The science component is the one with which the Congress and the NSF seems comfortable. Engineering Art, the individual's ability to create through the design of machines and/or static structures mentioned under the discussion of technology, represents an area which to date has received minimal NSF funding. This is the area where, in engineering education, the individual student's creative abilities are sharply honed. Up to date physical facilities such as those required for design laboratories are of the utmost importance for the student's depth of understanding and ability to create.

At a time when our government is concerned, rightly so, with the erosion of both the industrial base and the defense industrial base of our nation, failure to invest in the physical plant of our engineering schools will result in the denial of precisely this depth of understanding. It is false economy indeed.

Mr. **Walgren**. We appreciate it.

Dr. Wright.

Mr. **Wright**. Mr. Chairman, my testimony today is presented on behalf of the 368 member institutions of the American Association of State Colleges and Universities. It's a combined enrollment of over 2½ million students, AASCU institutions enroll 20 percent of all baccalaureate students in the country.

Predominantly undergraduate in focus, these institutions play major role in the education of our Nation's scientific manpower.

I would like to thank you for the opportunity to particiate in a discussion of an issue which we believe represents one of the crucial challenges to the well-being of our Nations education and research enterprise.

The motivation for the bill has been attested to by others today so I will pass over that portion of the prepared testimony.

I do wish to comment on several provisions of the proposed legislation and I do so within the context of strongly supporting its goals.

First of all, I believe that this legislation, conceptually, comes very close to addressing the needs of the academic community.

The title I provision authorizing NSF to design, establish and maintain a data collection and an analysis capability for research needs assessment also addresses several needs.

The information generated by such an assessment, however, would be even more valuable to institutions if it included an assessment of science and engineering educational facilities. Therefore, I encourage the subcommittee to consider broadening the scope of the needs analysis provision to include an assessment of educational facilities for science and engineering.

The committee is to be especially commended for recognizing the needs of colleges and universities which are not among the Nation's top 100 research institutions.

Mr. Fuqua stated in his testimony before this subcommittee, "research is a combination of people and adequately equipped laboratories." This is particularly true at these newly emerging institutions. The research institutions who have not attained the top 100 status also require special attention.

An example of this situation, with which I am very familiar, is the research institute on the campus of the University of Alabama in Huntsville. That facility was built in the early 1960's to house the university's major research endeavors—a role it continues to play.

In the 25 years since the research institute's construction, there's been no funding appropriated to upgrade and renovate that important structure. However, during the same period, the demands placed on the facility and its equipment have grown considerably. Those demands include the $9 million optical computing research mission of UAH's Applied Optic Center Director John Caulfield is administering for the National Strategic Defense Initiative.

They also involve the expectations created by NASA's 3 and a—three-quarter million dollar funding of the UAH consortium for materials development in space, a concern UAH is heading with a number of national aerospace companies.

In order to meet these and other demands, our facilities and equipment will require upgrading. Conservative estimates indicate that it would cost $1 million to provide for general renovation of the building and $3 to $5 million to make critical equipment improvement. Those figures do not include what it will cost to construct the additional space to the building needed to accommodate the research centers responsible for the new Federal projects I have just mentioned. However, I believe the size of this single example helps to illustrate the national importance of the bill.

The provisions in the H.R. 2823 setting aside 15 percent of the total funding for institutions not among the top 100 research universities begins to address the imbalanced distribution of Federal funds under the current system.

This provision, however, merely formalizes the distribution of research funds that now occurs through grant competition. Instead, I urge that this percentage be raised beyond the status quo.

On another note, I believe that the matching component of the bill provides an effective means for the Federal Government to encourage, and even pressure, other funding sources to help support the goals of this legislation.

This provision will also serve to strengthen the partnership between the Federal Government, institutions, and industry in their common commitment to the Nation's education and research infrastructure.

In conclusion, I believe that the facilities bill is based on a series of sound concepts about the needs of our education and research infrastructure. Simply stated, they include:

An acknowledgement that facilities are a real and mandatory factor in determining the costs of a comprehensive research infrastructure;

recognition that support for education and research facilities is an investment in our Nation's economy;

an appreciation of the benefits of a diverse research community and the corresponding needs of its members;

an understanding of the dependence of each institution's education and research efforts upon its physical infrastructure.

I urge the members of this subcommittee to keep these ideals in mind as you consider this issue. For if this legislation is to attack the facilities crisis with any degree of success, it must remain true to these goals.

[The prepared statement of Mr. Wright follows:]

STATEMENT BY

JOHN WRIGHT

PRESIDENT

UNIVERSITY OF ALABAMA IN HUNTSVILLE

ON

THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

ON BEHALF OF

AMERICAN ASSOCIATION OF STATE COLLEGES AND UNIVERSITIES

Before the
House Science and Technology Subcommittee
on Science, Research, and Technology
U.S. House of Representatives

October 22, 1985

Mr Chairman, and members of the Subcommittee, my name is John Wright. I currently serve as the President of the University of Alabama in Huntsville (UAH), a position I have held for the past six years. Since becoming part of the University of Alabama system in 1969, UAH has developed into a comprehensive institution heavily oriented toward high technology. The university currently enrolls 4500 undergraduate and 1500 graduate students.

Prior to assuming the presidency of UAH, I served as the chief academic officer for the West Virginia Board of Regents and as Dean of the College of Arts and Sciences at both West Virginia University and Northern Arizona University.

In addition to my administrative roles, I have served as a professor of chemistry at West Virginia Wesleyan University, Northern Arizona University, and West Virginia University. In 1951, I received a Ph.D. in Chemistry from the University of Illinois, following which I did post-doctoral work at the University of Michigan and the University of London. I have also worked for seven years as a research scientist in industry and have been a member of the National Science Foundation staff.

My testimony today is presented on behalf of the 368 member institutions of the American Association of State Colleges and Universities (AASCU). With a combined enrollment of over 2-1/2 million students, AASCU institutions enroll 20 percent of all baccalaureate-degree students in the country.

Predominantly undergraduate in focus, these institutions play a major role in the education of our nation's scientific manpower. In fact, studies show that a substantial number of students who ultimately pursue advanced degrees in scientific and technical fields receive their initial training at comprehensive, four-year institutions.

I would like to thank you for the opportunity to participate in a discussion of an issue which we believe represents one of the crucial challenges to the well-being of our nation's education and research enterprise: the condition of our education and research infrastructure.

In this vein, Mr. Fuqua is to be commended for his work in developing the University Research Facilitities Revitalization Act of 1985. H.R. 2823 provides a springboard for the type of discussion from which a viable solution -- supported by the Congress, the academic community, and the administration -- can emerge.

As you are well aware, our nation's colleges and universities are currently striving to achieve the dual goals of providing adequate facilities for the education of future scientists and engineers and continuing to allow faculty members to carry out research.

This task is especially challenging in science-related fields, where the cost of physical resources is far greater than in other academic specialties. The necessities and expenses of innovation are growing rapidly; specialized computer science, engineering, and science buildings now require more complex and diverse features in areas such as precision temperature control and air filtering systems. The result is that today's properly equipped science laboratory can cost in excess of five times the price of an instructional facility for a course of study in the humanities. And once built, science facilities also are more expensive to maintain.

Historically, the Federal Government has been the primary investor in developing the nation's educational and research facilities. This support has come in a variety of ways: the various research grant programs, loan subsidies, overhead cost payments, and, more recently, through direct appropriations.

According to a recent report by AAU/NASALCG/COGR on Managing Academic Research Facilities, federal support for academic research, including equipment, increased by an average of 15.7 percent per year during the period of 1953-1967. But since that time, the study reports, the rate of increase has dwindled to an annual average of 1.6 percent. The Federal Government's investment in the major capital expansion of college and university campuses has also declined rapidly since the early-1960's. Annual spending on R&D has decreased by 78 percent since 1966, when the period of growth following the Soviet launch of Sputnik in 1958.

In the past five years, several agencies have implemented programs aimed at helping to offset the instrumentation aspect of this trend.

In particular, the National Science Foundation, and the Departments of Energy and Defense have begun initiatives in the area of research instrumentation. In combination with tax incentives, these programs have made inroads into satisfying the equipment needs of the university research community. Still, support for instructional instrumentation -- tools essential in the preparation of a scientist or engineer -- is scarce, particularly for institutions without a strong research orientation.

Colleges and universities, themselves, are exacerbating the shortage of viable research facilities. In an era of strained institutional budgets, institutions themselves have put off long-term capital investments, instead focusing on meeting short-term priorities. Such planning is encouraged by our system of awarding support to individuals and not institutions, further hindering long-term planning for institutional instrumentation and facility needs.

As members of this Subcommittee, you are well aware of a growing consensus that the chronic needs of our academic facilities threaten the quality of our nation's educational and academic research capacities. And as noted in a report by the President's Commission on Industrial Competitiveness, our scientific knowledge and talent base are two significant advantages that we hold over our competitors in the world marketplace. The introduction of the Fuqua Facilities bill has given us the opportunity to take immediate action to restore the our nation's education and research infrastructure.

At this time, I would like to comment on several provisions of the proposed legislation. I do so within the context of strongly supporting its goals.

First of all, I believe that this legislation, conceptually, comes very close to addressing the needs of the academic community. The proposed ten-year matching grant program, designed to operate through the agencies currently supporting R&D activities, would provide the start-up funds and leveraging mechanism necessary for facility renewal and expansion. Such a program also would provide institutions with a viable alternative source of research facility support -- one that operates under the process of peer review to guarantee the best use of federal dollars.

The Title I provision authorizing NSF to design, establish and maintain a data collection and analysis capability for research needs assessment also addresses several needs.

This plan not only ensures feedback on the impact of the proposed program, but will help prevent a future facilities crisis by providing information essential for long-term planning. The information generated by such an assessment, however, would be even more valuable to institutions if it included an assessment of science and engineering educational facilities. Therefore, I encourage the Subcommittee to consider broadening the scope of the needs analysis provision to include an assessment of educational facilities for science and engineering.

Mr. Fuqua is to be especially commended for recognizing the needs of colleges and universities which are not among the nation's top 100 research institutions.

As he stated in his testimony before this subcommittee on July 30, "research is a combination of people and adequately equipped laboratories." This is particularly true at these newly emerging institutions, where faculty members are committed both to participating in federal R&D programs and to educating science and engineering students who terminate their education with a baccalaureate degree.

The efforts of these researchers produce benefits other than the practical research gains, helping to promote the continued advancement of our nation's scientific effort. In fact, a recent study by the Great Lakes Colleges Association concludes that a high proportion of science graduates from primarily undergraduate institutions go on to succeed in post-graduate work, earn doctorates, and become faculty members at leading research institutions.

At the same time, the research institutions who have not attained Top 100 status also require special attention. Without the resources of graduate and research programs, these institutions face the difficult task of balancing the high costs of increased science and engineering enrollments with declining enrollments in lower-cost liberal arts programs.

The provision in H.R. 2823 setting aside 15 percent of the total funding for institutions not among the top 100 research universities begins to address the imbalanced distribution of federal funds under the current system.

This provision, however, merely formalizes the distribution of research funds that now occurs through grant competition. Instead, I urge that this percentage be raised beyond the status quo so as to more adequately reflect the contributions made by these institutions which, due in part to their commitment to the education of science and engineering baccalaureates, are not highly research oriented.

I would also recommend that the Subcommittee encourage dual usage of facilities constructed or renovated under this program. Such a provision would help underscore the need for both educational and research activities as a means of improving the nation's science education and research.

On another note, I believe that the matching component of the Fuqua

Facilities bill provides an effective means for the Federal Government to encourage -- and even pressure -- other funding sources to help support the goals of this legislation.

This provision will also serve to strengthen the partnership between the Federal Government, institutions, and industry in their common commitment to the nation's education and research infrastructure. It should be noted, though, that the matching requirements present steeper challenges to smaller institutions, many of which are just beginning to develop a constituency of donors.

In considering this bill, I would encourage the Subcommittee to engage in some discussion of support for the maintenance and operation of the facilities which would be provided for under this legislation. With the benefit of hindsight, it can now be said that greater consideration of this issue in the 1960's would probably have extended the lives of building that we are struggling to renovate today. It would be an error of short-sightedness to ignore this issue once more.

Finally, I urge the Subcommittee to give careful attention to the impact that the implementation of H.R. 2823 would have on the current research base. Consideration should also be given to means of ensuring stability in funding the program in the future.

In conclusion, I believe that the Fuqua Facilities bill is based on a series of sound concepts about the needs of our education and research infrastructure. Simply stated, they include:

- o An acknowledgement that facilities are a real and mandatory factor in determining the costs of a comprehensive research infrastructure
- o Recognition that support for education and research facilities is an investment in our nation's economy
- o An appreciation of the benefits of a diverse research community and the corresponding needs of its members
- o An understanding of the dependence of each institution's education and research efforts upon its physical infrastructure

I urge the members of this subcommittee to keep these ideals in mind as you consider this issue. For if this legislation is to attack the facilities crisis with any degree of success, it must remain true to these goals.

Mr. **Walgren**. Thank you very much, Dr. Wright.

Well, we certainly appreciate the range of comment that all of you have given us.

Can I ask for some general reaction to this 15 percent provision, along the lines of what your instincts are that our distributive functions should be. I do think that there certainly is the potential for schools to be left and then never to be able to get back into the competition. And we do know that under present peer review approaches, at least by the National Science Foundation, there are institutions that don't do as well as others in those competitions. And there are sections of the educational process, and particularly the undergraduate liberal arts area—but you indicate also, Dr. Wright, the smaller engineering schools which are providing substantial training grounds for future researchers that we do rely on, and yet they are coming through without any contact at all with the kinds of resources which we want to provide those who go on to become our best scientists.

The present 15 percent, as Dr. Wright says, is about the present distribution among the schools. In other words, those those who aren't in the top 100—get 15 percent of the Federal research dollars. And here we would say, well, they got 15 percent on that scale, we will give them 15 percent on this—in this function—on this purpose.

Are you folks concerned about schools being left out of this process and then not being able to attract and hold the critical mass, as I think Dr. Hosler was mentioning—if I am not mistaken, who that was.

Dr. Rosenberg, do you want to start?

Mr. **Rosenberg**. Well, there are certainly many needs that our colleges and universities have. I had thought that the specific focus of H.R. 2823 was on research facilities and not on training and more broadly defined educational facilities.

I agree that if you want to look at all the needs, the bill will be more than half a billion dollars a year of Federal participation and more than $1 billion a year total costs. I think that the 15 percent minimum funding for the institutions not in the top hundred of current research grant funding is a reasonable one within the context of the bill as defined by its title and by its purpose.

Mr. **Hosler**. I would like to comment, too, that I think one of the richer parts of our system in this country and education is its diversity. And while I applaud Dr. Sissom's organization, ABET, that credits universities and tries to maintain some minimum standards, I think we do run a risk if we do anything to weaken the smaller institutions of somehow limiting that diversity. In a rapidly changing society, one never knows who is giving the education that might be the best fit for future needs.

So I think the 15 percent is appropriate. And as was indicated, if you really want to embrace the total educational experience, you are going to incur a much bigger indebtedness than we are talking about with your $500 million a year. I think it is a legitimate and important concern to maintain this diversity and the availability of education geographically to the largest possible segment of the population. The whole land-grant principle—some of us here represent land-grant institutions, is to educate the sons and daughters of the working classes, and sometimes you have to make that geographically available because some of these people are not able to go large distances to obtain an education and pay a very high price.

So I endorse the idea of trying to assure that smaller institutions are not shut out of this process, but it would require very careful screening to make sure they don't try to do everything across the board and that they concentrate in some areas of engineering, for example, or some areas of science, because there's no way every institution in the country can have a full complement of equipment and expertise in every field. So you have to be very careful that you don't spread yourself too thinly.

Mr. **Sissom**. May I piggyback on that, please, and also onto Dr. Wright's statement a moment ago.

The number I gave from the ASEE study over a 7-year period of 8 point something percent reduction in space per graduate student, was 38 percent for the smallest of the schools, if you divide them into four categories—it was 38 percent for the various—for the smaller schools. And we are talking about per graduate student—the reason that parameter was selected, of course, is they are allegedly doing research in graduate programs is the reason it fits.

Mr. **Walgren**. There were also graduate students in the smaller institutions?

Mr. **Sissom**. Oh, yes. Yes, the number is per graduate and not per—per total student.

Mr. **Walgren**. So something very different is going on in the smaller schools——

Mr. **Sissom**. That's right.

Mr. **Walgren** [continuing]. Than is going on in the larger schools.

Mr. **Sissom**. Yes; and I think this would argue for increasing the number, as Dr. Wright said, although I said in my presentation that I think the NSF assessment will help us know more what we ought to do. I think the data will be better when that assessment gets under way.

Mr. **Hosler**. As graduate schools and we have a stake in these smaller schools, larger research universities, because these are a source for graduate students, and we would like to see them enter in graduate school with appropriate educational experiences based on up-to-date laboratories and computers, and so forth.

I could, again, cite anecdotal evidence of people from some—and I have done a lot of lecturing at small universities and sometimes I'm appalled at the lack of facilities and lack of expert faculty in institutions that are giving engineering degrees, or chemistry degrees, or physics degrees. And I think the figures you quote—as Dr. Sissom has quoted—indicate that we have somewhat depreciated the facilities and the expertise available in many of these small institutions.

Mr. **Walgren**. Now one of my sort of recurring thoughts is that although you probably can and should resist concentration at every juncture if there were other parts of the system that were heavily committed to distributive strength, or increasing the strength in a distributive way—you mentioned a geographical way—as far as I know, at least within the National Science Foundation there's zero geographical requirement.

Now, there is a distributive requirement but in a very small program, and I don't know what we are doing in land-grant area. I suppose the States are doing something there.

But my point is that if you had real commitment in other parts of the system to assure the quality of education in institutions that might not be able to compete for these grants, you would be more willing to allow the grants to be more focused. But absent that, it really makes you want to resist the concentration of targeting these kinds of resources.

And I guess—another question just for discussion—when the National Science Foundation was first created, they did recognize that the tendency of concentration in academic research and attempted to urge the Foundation to work against that. But it seems that in those intervening 35 years, we are crossing a threshold where the natural forces of concentration are dramatically accelerating as instruments become so singular and beyond the reach of the ordinary educational institution. And has that gone to the point—has that accelerated to the point that we really better start to resist programs that would tend to concentrate research capability to the exclusion of other institutions?

Mr. **Hosler**. There is a National Science Board study which I saw last month which addresses this geographic distribution and I think shows that things are pretty well distributed geographically in proportion to population from NSF.

You might want to look at that study. I think that does handle that pretty well.

But I think the colonel from DDR&E who testified earlier this afternoon indicated they are addressing the fellowship problem and travel grants, and so forth, to give access to these facilities on the part of people from smaller institutions or from large institutions where there are concentrated facilities that can only be one of a kind, or two or three of a kind. I think that's a very important concept that there be fellowships available, or internships available so that at the very least, faculty and graduate students can have access to these one or two of a kind facilities. Very often the facility would be available to them were they able to sustain themselves at that facility for the summer months or for a few months a year to do experiments—and that does happen in large part in some facilities which have built-in funds, whether it's Argonne Laboratory, or Brookhaven, where there are built-in funds to provide access to their facility on the part of people from all over the country.

Mr. **Walgren**. Dr. Anderson?

Mr. **Anderson**. Well, happily, I think, to some extent this problem is self-regulating, at least in one aspect. Large universities that are pursuing very complicated research programs demanding very large and expensive and complicated instruments, also require specialists to operate and to run them.

This bill being directed towards the equipment part of the equation, you see, allows universities, large or small, to participate in the program, whatever their means, and the responsibility of picking up the operational costs and the personnel costs, and so forth, that go to this part of the equation come from another source. And earlier I called attention to the decision—the programmatic decisions that had been made in the past decade or so—program managers have been somewhat analogous to having a common community automobile where everyone is pretty willing to put in the money for the gasoline and to feed the car the gasoline, but nobody thinks much about the oil and the tires.

And our problem now is simply we have neglected a very essential part of our overall research enterprise that happens to be centered in the equipment area, maintenance of equipment, the replacement, and so forth. And the virtue of this bill is directed specifically to that part of the problem. And for my part, I recognize the legitimacy of what's been said about the needs of small universities and so forth, but I do not personally think they are threatened in any way by this bill.

Mr. **Walgren**. Dr. Wright?

Mr. **Wright**. I would—to take a slightly different tack—I think you are onto an issue that is of national significance and probably isn't being discussed by universities, and that is the distributive issue. I don't think it's primarily an educational issue. I think it's an economic issue. That what we find, I do believe, is the concentration that you referred to where it's more and more—getting more and more concentrated, because the Government research support in the university provides a nucleus for economic development. And so that the distribution of research funds is no longer just an educational matter, or a research matter, it really is an economic matter, because where those funds go they nucleate an industry which will be the modern industry of tomorrow. And so I think there is a distributive issue because the distribution of Federal money really controls the economy in that part—in the proximity to where the money is being distributed, and it is not just a matter of research and education.

Mr. **Walgren**. And that would feed on itself to the degree that the local industry then provided the matching grants for future funding and—if you weren't in that first round, you fall behind pretty fast.

Mr. **Wright**. Yeah. If you are trying to build a high technology cluster today, then you are—you've got a difficult problem with catching up, that's right.

Mr. **Hosler**. That's one of the reasons I felt you could maybe leverage those funds to a greater degree than is specified in the bill because there is the local interest on the part of business and industry, and on the part of the State development of authorities. So that they are willing to ante up because they see the industrial development which follows the research.

Mr. **Walgren**. Of course, a true have-not university would really have trouble matching a 70 percent, coming up to 70 percent as opposed to 50 percent.

Mr. **Hosler**. Probably so. But it would be a good motivating factor for their development office. [Laughter.]

Mr. **Walgren**. Did you want to add something, Mr. Baker?

Mr. **Baker**. On a slightly different topic, Mr. Chairman.

Mr. **Walgren**. Sure.

Mr. **Baker**. I wanted to—to give my answer to your earlier question this afternoon concerning the relative magnitude of the funds proposed to be appropriated. And my answer is, if I can rely on the number which we have developed for our system and extrapolate that nationally, one would find that probably something on the order of $15 billion rather than $10 billion would be—that's how my calculation would come out. So at least by that crude measure, one can see that the $10 billion certainly is in the right ball park.

Mr. **Walgren**. Uh-huh. Is that based on your $4 billion number——

Mr. **Baker**. No, no, sir.

Mr. **Walgren** [continuing]. Or your $1.6 billion?

Mr. **Baker**. It's based on the $1.6 billion. If I assume that some 80 percent of the $1.6 billion are for science and high technology, that calculation comes out about $13 billion, or $12.8 billion in fact.

Mr. **Walgren**. I see.

Mr. **Baker**. So by that calculation at least it shows that the $10 billion is certainly in the right ball park and not overstated by any means.

Mr. **Walgren**. Do you have any advice on the question of criteria for the competition? How are choices to be made between these proposals? Now, I guess each agency would be a little bit different. You have multiple funding sources here, each making its own decision, and I guess using their own criteria. But are there ways that—I suppose there are ways you could work those criteria to be more inclusive of some settings that would otherwise excluded. Your criterion was that you wanted to build strength where it is presently not. You could select for the opposite, couldn't you?

Do you have any suggestions on criteria that—you know, we all say, well, we want quality and we want excellence. How is that to be judged? Yes?

Mr. **Rosenberg**. Well, I think one criterion that hasn't been mentioned is the manner in which the proposed activities fit in with defined national need, whatever that is—each of the six agencies has its own menu of projects which in a given year or in a given 5-year period it thinks are important to be pursued. So I think that's certainly one of the important criteria.

Second, to the extent to which I take the reading of the bill that the aim of the bill is to further research capacity of the country—one has to look at quality. I think that that is really almost the overriding criterion. I think that there can be some distributional ones that can be added, but certainly the question of quality cannot be left out.

Mr. **Hosler**. If you take the inverse to that, you could dispense unlimited funds and perhaps not wind up with much of a product at all if you did it all on a distributive basis and used the inverse of track record or credibility based on past performance. It seems to me the minimum of your 85 percent has to be based on national needs plus track record and performance and I think it's very important as to whether an institution or the community in which an institution resides is willing to make a partial investment. And so even as written with the 50 percent matching you have a pretty good guarantee that people must have some commitment in an area before they are going to get any of these funds. I think that commitment is terribly important.

Mr. **Walgren**. The bill as it's written mentions that the criteria will include, among other things, the contribution which the project would make toward the range of training needs—national, regional, and State research and related training needs.

Now, if you were to turn something like that over to these agencies they would essentially have a free hand at that point, wouldn't they? And they really could choose whatever project they wanted to choose because it's not stated in the bill how they are to weight this, so that they really would be able to direct those funds wherever they chose to direct them at point, wouldn't they?

Mr. **Hosler**. Yes, very flexible.

Mr. **Anderson**. I think this is one of the most attractive features of this bill, that it's written in what seems to me to be in an extraordinarily well balanced fashion. There are some things about it that may be a little trouble seem to—troublesome to one party or the other. Now we have to take into account, as you have in the early session, the feelings of the agencies—and I noticed that they were not overly enthusiastic about this bill. I was surprised but—that there wasn't more enthusiasm for it than I detected. And I am surprised and sorry, too, that there was not. Nevertheless, we can be relieved that there was not outright opposition and they may go along with it. And I think that's one of the things that will characterize these hearings and the debates as the bill goes through its process. But quite honestly, to say again, I think it's well balanced.

And I say other—one other thing, too, about the experience in the private sector. It may be useful for you to get the advice of some people from basic research laboratories in the private sector. And I would suggest the Exxon Laboratories, the Schlumberger Laboratories, the Shell Development Laboratories in our State. And when you talk to them about how they finance their equipment and manage their equipment, you will be surprised perhaps to learn that a 45 percent over—overhead rate, or indirect cost recovery rate that was being cited earlier today, doesn't come anywhere near covering the indirect costs that are actually associated with the research operation. Indirect cost rates that are charged within the company in most of these places are 100 percent, or thereabouts, and in some cases exceed 100 percent.

Not only that, if you look into the Shell Development Laboratory and see what their inventory is, you will find they have a little more than $100 million worth of analytic equipment in this one laboratory in Houston, and they spend $4 million each year on maintenance and operation of the equipment, and another $5 million on new acquisitions. This is just to keep current. And they spend the minimum that they have to spend in order to meet their competition.

When you look at the full cost of an operation like that in the private sector, you begin to realize the predicament that universities find themselves in today.

Mr. **Walgren**. As we——

Mr. **Baker**. Mr. Chairman——

Mr. **Walgren**. Mr. Baker.

Mr. **Baker** [continuing]. On that topic, you asked earlier—I believe you or one of your colleagues—asked Mr. Bloch the question related to funding for Department of Energy laboratories or other national laboratories. We manage three Department of Energy laboratories, and I can tell you that the difference in quality sophistication and advanced state of the art of the equipment in those three laboratories and our campuses is absolutely striking, and there just is no comparison. So there is clearly from that one piece of data a remarkable difference in the level of funding for instrumentation and facilities in those laboratories as against at our campuses.

Mr. **Hosler**. I don't know what your understanding was, but when I listened to the testimony earlier today, it seemed to me that what NSF and DOD are doing now exceed what is called for in this bill and would result in no change, or perhaps a decrease if they wanted to take the bill as gospel. The bill doesn't address what is happening now. I don't know how it will look in the other agencies addressed in the bill, but as I listened to that discussion, I had the impression that maybe this doesn't do anything if the other agencies are already addressing the problem in the way DOD and NSF are.

Mr. **Rosenberg**. Well, I think it depends on what—how you define facilities. Is it facilities plus equipment and is it equipment over $10,000, equipment over $100,000, equipment over $1 million? It's true if you take equipment plus facilities, NSF is doing better than that now.

Mr. **Hosler**. Yes, and——

Mr. **Rosenberg**. And DOE also.

Mr. **Hosler**. I'm not familiar enough with that.

Mr. **Rosenberg**. I had thought this bill was coming to the part that's been neglected. We've seen this wonderful new push towards support of instrumentation equipment, by DOD, NIH, DOE and NSF in the past 3 years. But the part that's been left out in the Federal participation level is the bricks and mortar in your wording of——

Mr. **Walgren**. How the definition of the equipment was divided between heavy, fixed equipment as opposed to portable equipment—is that the idea? And the way I heard it, I heard NSF would have satisfied the test if you consider fixed equipment. But the DOD did not—most of their money was going into a more transferable, or specific equipment effort, and that they felt they would be short on the fixed equipment plus a bricks and mortar formula.

Mr. **Rosenberg**. Well, Mr. Bloch did mention ships and wind tunnels. But I think lots of that money is for computers and for spectrophotometers and things that can be hauled in and out.

Mr. **Baker**. I might say that definition is really critical here in trying to discuss this with some degree of intelligence. And I suspect that—that as we look at our equipment needs, instrumentation needs—at least in our—based on our inventories, we just simply don't have the resources, and the Federal money just isn't there to outfit the laboratories as we need to, particularly in those advanced state-of-the-art sciences. And another factor there is that the cost of the equipment for today's science has really multiplied exponentially. I think I heard earlier cited a $300 microscope and now it's $1 million—for an electron microscope. Well, that—those are real numbers. Those aren't imaginary numbers, they are real—and that certainly exacerbates the problem.

Mr. **Walgren**. Well, all right. Well, we certainly appreciate your coming and talking about this with us and for the record, and we look forward to interacting with you and trust you will follow what you hear about it and send us any further comments and views that you come across. We appreciate your being a resource to the committee. Thank you all very much.

[Whereupon, at 4:30 p.m., the subcommittee adjourned.]

H.R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

THURSDAY, OCTOBER 24, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to recess, at 1:43 p.m., in room 2318, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Mr. Walgren. Let me call us to order. I apologize for the late start.

This afternoon the subcommittee continues its hearings on the research facilities modernization problem at U.S. colleges and universities. We have asked our witnesses to provide us with their general views on facility needs and their suggestions on how to meet those needs, particularly in light of House bill 2823, the University Research Facilities Revitalization Act, which has been introduced by the chairman of the full Science and Technology Committee, Representative Fuqua.

As I mentioned at the beginning of our hearing on Tuesday, there is a lot of interest in this legislation, and many groups, institutions, associations, and individuals have offered us their views, and we encourage that to happen.

We have received more requests to testify than we can accommodate, but our subcommittee remains open for views and positions that people would like to submit, and we will be able to incorporate at least a good number of those in the record which we ultimately create.

We have a number of witnesses today, and I think I should say, in the interest of time, that I would ask you to make your presentations as direct as you can. Full statements will be reproduced in all their fullness in the record for later review by everyone who will have access to that, including the general public.

So in terms of the written statements, there will be no problem in having them be literally part of the record, and I certainly would encourage you to focus on parts and points which you really would like to underscore, because it will then stand out in the process more fully than if it is simply part of a written submission. So I would encourage you to focus on that.

We will hold the record open here for opening remarks of our ranking minority member, Congressman Boehlert, who we believe will be here shortly.

I would like to recognize our colleague from North Carolina, Mr. Valentine, for an opening statement.

Mr. **Valentine**. Thank you very much, Mr. Chairman.

The legislation which we are considering this afternoon, the University Research Revitalization Act of 1985, is of great importance to our entire Nation as well as to our research universities. Our research universities have a dual role. Not only do they provide the facilities for actual research, but they also train our future scientists and engineers. The students at our universities today will help us to remain dynamic, innovative, and competitive tomorrow.

I am delighted that we will hear from an outstanding group of witnesses today, and I am especially pleased that among these witnesses will be Dr. Craufurd D. Goodwin, dean of the graduate school and vice provost for research at Duke University in Durham, NC.

Dr. Goodwin is a distinguished economist who has authored a long list of scholarly publications. He has also directed several major economic projects for the Ford Foundation and the Brookings Institution.

Dr. Goodwin's participation in this hearing is important for two reasons. First, his advice, based on his experience and expertise, will be invaluable to this subcommittee. Second, his presence is a reminder of the major center for scientific research and development located in the Raleigh-Durham-Chapel Hill area of North Carolina.

Duke University, the University of North Carolina, North Carolina State, North Carolina Central University, and Research Triangle Park, and a number of related institutions constitute one of the most productive centers of advanced research in the United States.

Dr. Goodwin will describe some of the projects and efforts in which Duke is involved and explain the importance of Federal funds in providing up-to-date facilities to support this research.

Without my presenting a project-by-project or discovery-by-discovery account of the scientific leadership of this portion of the Second District of North Carolina, I think that my colleagues will agree that the Research Triangle is an impressive example of the potential benefits of cooperation among Government, universities, and the private sector.

I believe, Mr. Chairman, that the subcommittee will learn much from Dr. Goodwin and these other witnesses. This is a vital subject. Our research universities are a national resource which must be maintained and modernized if the United States is to continue to stand for innovation and leadership.

Thank you, Mr. Chairman.

Mr. **Walgren**. Thank you, Mr. Valentine.

We want just to clear unanimous consent for any photographs and television taping that folks may be interested in doing. Without objection, you are very welcome to be here, and we are glad you are.

The first panel, let me call to the table Dr. Don Phillips, who is the executive director of the Government-University-Industry Research Roundtable; Dr. John Sherman, vice president of the Association of American Medical Colleges; Dr. David Garin, treasurer of the National Coalition for Science and Technology, who is accompanied by Dr. Phillip Speser, executive director of the National Coalition for Science and Technology; and Dr. Craufurd Goodwin, as Mr. Valentine has said, vice provost and dean of the Graduate School of Duke University.

Gentlemen, welcome to our record here. Just for continuity's sake, why don't we start off with Dr. Goodwin, and then fall back into the order in which I introduced you for the record.

Dr. Goodwin, why don't you just start off? Welcome to the committee.

STATEMENTS OF CRAUFURD GOODWIN, DEAN, GRADUATE SCHOOL, AND VICE PROVOST FOR RESEARCH, DUKE UNIVERSITY; DON I. PHILLIPS, EXECUTIVE DIRECTOR, GOVERNMENT-UNIVERSITY-INDUSTRY RESEARCH ROUNDTABLE; DAVID GARIN, TREASURER, NATIONAL COALITION FOR SCIENCE AND TECHNOLOGY, ACCOMPANIED BY PHILLIP SPESER, EXECUTIVE DIRECTOR, NATIONAL COALITION FOR SCIENCE AND TECHNOLOGY; AND JOHN F. SHERMAN, VICE PRESIDENT, ASSOCIATION OF AMERICAN MEDICAL COLLEGES

Mr. GOODWIN. Thank you, Mr. Chairman, and members of the subcommittee. I appreciate the opportunity to appear before you today. My name is Craufurd Goodwin. I am dean of the graduate school and vice provost for research at Duke University in Durham, NC.

I have submitted written testimony which has been distributed to you. In the few minutes available to me now, I would like to review the highlights of this testimony.

First of all, I must emphasize that this proposed legislation responds to an enormous problem facing all research universities today: how to house and to sustain the research of those members of our faculties who stand at the rapidly changing frontiers of science. The science which we do in our laboratories and on our computers and research vessels is the principal means through which this Nation retains its technological superiority, yielding both the ideas and the trained personnel upon which a modern economy depends.

The problem for the sponsors of science today—Government, private industry, and universities—is not simply to replenish people and instruments. Advances in knowledge sometimes force changes in the form and style of scientific endeavor, rendering inadequate or obsolete the large capital structures which house the science. How are these to be replaced? Inattention to these fundamental needs will block the progress of science even when other needs for training and equipment are attended to.

I have drawn attention in my written testimony to several major research facilities on the Duke University campus which are operated cooperatively with our neighboring institutions, the University of North Carolina at Chapel Hill and North Carolina State University at Raleigh, all of which were built with some form of Federal assistance under earlier enlightened legislation.

I described the Triangle University's nuclear laboratory, the Phytotron, and the Triangle University's computation center. I might have added also, the research vessel *Cape Hatteras*, operated jointly for the National Science Foundation.

These facilities are all now in need of new construction because of the rapidly advancing science in the fields they represent. We cannot envision where construction funds can be found without significant leadership from the Federal Government. This condition is just as true for our traditional science departments such as chemistry, geology, or computer science as for the special cooperative facilities. Put most simply, the price of staying on the frontier of science is providing adequate facilities for research. The need grows virtually as rapidly as does the imagination of our scientists.

I especially like the matching requirement in the bill. Even though for a private university this condition can be onerous, I think this feature acknowledges the need for at least a quadapartite partnership in meeting this challenge. A matching provision will ensure that the State governments, the private sector, and the universities themselves will join in to achieve a result which is in our mutual interest.

I do hope that at the start of this program at least some means may be found to make the funds aimed at facilities revitalization additive to, rather than substitutive of, research and development funds now in the departmental budgets.

I appreciate the serious problem of the budget deficit, but I am mindful also of the dependence we have upon technological improvement to bring about the economic growth which will help to eliminate this deficit. It will be regrettable if the funds to revitalize our research facilities must come at the expense of the science that takes place in those facilities.

I have very few suggestions for adjustments in the bill. I recommend that the coverage be extended specifically to include such research-related capital facilities as repair shops and the fixed equipment that goes into them. At the same time, I think it should be made very clear that this is not a bill to provide for new research instrumentation.

Also, I would like to see consideration given to a larger role for the National Science Foundation in the distribution of funds under the bill. The NSF unquestionably has the experience, tradition, and mission to distribute these resources efficiently and fairly through a competitive peer review process.

Let me thank you again for affording me the opportunity to speak to you today in support of this farsighted legislation. I will be delighted to answer any questions.

[The prepared statement of Mr. Goodwin follows:]

Testimony of

Dr. Craufurd Goodwin
Dean, Graduate School
and
Vice-Provost for Research

DUKE UNIVERSITY

on

H.R. 2823

University Research Facilities Revitalization Act

October 24, 1985

before

Subcommittee on Science, Research and Technology

Science and Technology Committee

House of Representatives

U.S. Congress

TESTIMONY OF CRAUFURD GOODWIN

Duke University

October 24, 1985

Mr. Chairman, and members of the Subcommittee, I appreciate the opportunity to appear before you today. My name is Craufurd Goodwin and I am Dean of the Graduate School and Vice-Provost for Research at Duke University, in Durham, North Carolina.

The bill before you, H.R. 2823, addresses an important problem on university campuses. Before commenting on the specific provisions of the bill, let me share with you a few observations regarding the need for the federal government to invest funds in capital resources for research, using the situation at Duke University as an example.

Research Revitalization Needs at Duke

Duke University has a mixture of typical and unusual research facilities. In addition to science and engineering laboratories, libraries, machine and electronic repair shops, the University has a large animal care facility, a regional computing facility, shared with two other neighboring research universities, a special plant growth facility called a Phytotron, and a regional nuclear laboratory facility called TUNL, or Triangle Universities Nuclear Laboratory. All of these specialized large research facilities have been generously supported by federal funds. Some of the major funding agencies have been the National Institutes of Health, the National Science Foundation, and the Department of Energy. Indeed, it is accurate to say that without the support of these agencies, these facilities would not exist.

The history of the construction funding for two of these regional research facilities, TUNL and the Phytotron, is instructive, as it illustrates the effectiveness of just the sort of matching funding model proposed by the bill. Back in the mid-1960's the National Science Foundation had two programs that funded research facilities construction and renovation--the Graduate Science Facilities Program and the Specialized Research Facilities Support Program. These two programs partially funded the construction for both of these facilities, with Duke University providing matching funds. The facts suggest that, without the federal matching program, several hundred graduate students in the fields of nuclear physics and plant biology (including George Keyworth, the President's Science Advisor) would not have had access to these unique research and training resources. Since the completion of these two facilities in the mid-1960's, the graduate students working both at TUNL and the Phytotron have come not only from Duke but from our neighbors, the University of North Carolina at Chapel Hill and North Carolina State University at Raleigh.

TUNL, I should add, is the home of the world's first Cyclo-Graff, which is used to make precision measurements for neutron and charged particle reactions. The Phytotron is one of two or three controlled plant growth environment facilities in the United States. The building has more than 46 separately controlled growth chambers which can be used to test the growth responses of different plants under different conditions.

Neither of these facilities has been renovated or substantially added to since it was built in the mid-sixties. Both foresee the need to expand within the next three or four years. At this point it is not clear where the funds will come from to finance the construction.

Consider the example of TUNL. The facility's operating costs are covered by a five year contract with the Department of Energy. DOE can request a line item appropriation for capital expenditures for TUNL in a future appropriations bill but there are problems with this mechanism aside from its vulnerability to the legislative process. The main problem, from TUNL's point of view, is the lag in time between when TUNL provides DOE with an estimate of its capital costs and the time the money is appropriated, roughly two years later. In the interim the capital costs have risen and other changes have taken place. Yet DOE does not have the authority to provide other funds to make adjustments, leaving TUNL with a debt, if the project proceeds, that must be paid. The restrictions on DOE's funding of capital resources from its regular R&D budget are severe. DOE grantees cannot even buy furniture with DOE funds.

The operators at the Phytotron have several capital projects in mind, if funds were to become available. All could make new and valuable research possible. One major need is for tall growth chambers. All of the present ones are seven feet tall. This means that only young plants can be studied in the chambers. Tall chambers, of 12 to 13 feet, could accomodate older plants, especially trees. Such chambers could be fitted into the present building. Of course, even more useful would be to construct an addition to the building that could accommodate taller chambers, with room for several trees at once, making helpful comparison studies possible over longer periods of time. A second need is for an air filter system to cleanse the air coming into the Phytotron of the chemical pollutants that are increasingly a problem in North Carolina. Such pollutants may be affecting the growth of the plants in the laboratory.

Another important regional research facility is the Triangle Universities Computation Center. A jointly supported regional computer network of the three universities, Duke, UNC-Chapel Hill and NC State, TUCC will be the logical place for the region's first supercomputer, as soon as the funds become available. An attachment to this testimony provides additional information about some of the important research under way at TUCC.

Returning to the subject of Duke University's needs, the university's regular laboratory space is an equally important component of its research facilities. Here the need for renovation and construction far outpaces the university's resources. In this, Duke's situation is quite typical of that found at most major research universities, including our nearest neighbors, the University of North Carolina at Chapel Hill and North Carolina State University. To illustrate, let us consider the example of the needs in the discipline of chemistry.

Seventeen years ago, Duke University constructed a sorely needed new chemistry building. Again, the early history of the building's financing illustrates the key role that the federal government has played in the provision of research and teaching buildings. Of the $7.9 million in total construction costs of the new chemistry building, the National Science Foundation's Graduate Science Facilities Program provided over $1 million. Duke covered most of the rest of the cost.

Today, this highly used facility can no longer meet the needs of the chemists whose research it houses. The design of the building was appropriate for the chemistry of those days, which was primarily synthetic chemistry. Synthetic chemistry requires a significant amount of bench space and many ventilation hoods and other devices to remove the fumes from the building. The chemistry building is therefore well supplied with bench space and hoods. Not surprisingly, since the building was constructed, the laboratory needs of synthetic chemists have changed. Lasers are now commonly used for routine synthetic applications, as well as in many other fields of chemistry. This technology requires different kinds of space and safety resources. In addition, the frontier work on the interface between biology and chemistry, now a very active field, requires containment facilities never dreamed of as necessary in 1967.

Another change in the discipline of chemistry that has important implications for the research facilities is the need for temperature control. This is the result of the movement in the field away from large-scale synthetic work and towards physical applications. Not all buildings built in the 1960's can be adapted readily to adequate temperature control, making new buildings necessary if new ventures in chemistry are to be pursued. In the words of the chairman of our Chemistry Department, Dr. Charles Lochmuller, "better space means better chemistry."

Comments on H.R. 2823

The bill H.R. 2823 as proposed would certainly help to channel federal funds to finance needed construction and renovation in academic research facilities across the country. Since, however, you are well aware of what the bill seeks to accomplish, let me focus instead on how the bill might be improved to achieve these goals more effectively.

An obvious and important issue to which you have no doubt already given some thought is the question of how to define "research facilities." Since the bill contains no definition, let me propose one. In the bill, research facilities should be defined to mean:

> buildings or parts of buildings where research is conducted, machine shops and other fabrication and

repair facilities for research equipment, and fixed research equipment.

Machine shops and other fabrication and repair facilities for research equipment are included in the definition because they are a key resource facility for researchers. When such shops are poorly equipped, with out-of-date machinery, frontier research can grind to a halt. As research equipment becomes more widely computerized and electronic, sophistocated repair shops are even more essential. Universities subsidize the costs of operating these shops, but the expense of purchasing new equipment for them is sometimes impossible for universities to afford. It is unfortunate but true that universities tend to postpone buying such equipment.

Notably excluded from my proposed definition is the broad term, "research equipment." In my view if the term is used in its general sense,instead of the narrower term, "fixed equipment," the impact of the bill on the research facilities of the nation could be significantly muted. Federal mission agencies with a proven reluctance to fund construction and renovation would meet the bill's spending requirements by allocating the "research facilities" monies on research instrumentation instead. More funds are always needed for research equipment, but such a practice distorts the intentions of the bill and should not be permitted. Facilities needs are also great.

A second issue is the formula the bill uses to determine the amount each agency would be authorized to spend. In the current version, that amount would be roughly proportional to that agency's current obligations for R&D to universities and colleges. By this formula, using fiscal year 1987 authorization figures, the National Science Foundation would be responsible for roughly 1/5 of the "pot." It is interesting that, in 1968, universities received about 1/2 of their R&D plant funds from the National Science Foundation. That fact is certainly borne out by Duke's story. There may be great legislative and political wisdom in using the bill's present formula to distribute the funds across the agencies. Yet historically the National Science Foundation's commitment to university research facilities and university basic science has been much more central than this formula reflects. Perhaps that agency's enormous experience and understanding of the nature of research at universities , as well as the key role it played in the 1960's in building the current infrastructure, ought to count for something in the bill's design.

A third issue relates to the bill's technical funding provisions. It is probably important that the bill require the appropriation of new funds for the program for a period of several years before the 10% clause is triggered. This would help to avoid an abrupt dislocation of the R&D system that might result if the program had been funded with new funds for only one year; several years of new funds would provide the agencies with more years of experience with the program before its requirements were incorporated into the agency's R&D budget.

In closing, I would like to thank you for inviting me to share my thoughts with you today. I commend the Subcommittee for its foresight in recognizing the contribution that our research facilities make to the quality of the research we conduct. I would be happy to answer any questions.

APPENDIX ATTACHMENT TO THE TESTIMONY OF

DR. CRAUFURD GOODWIN
DEAN, GRADUATE SCHOOL AND
VICE-PROVOST FOR RESEARCH
DUKE UNIVERSITY, DURHAM, NC

AT HEARING ON H.R. 2823

THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

OCTOBER 24, 1985

Prepared by
Leland H. Williams, President & Director
Triangle Universities Computation Center

I. RESEARCH TRIANGLE ACADEMIC AND RESEARCH ENVIRONMENT

The Research Triangle area of North Carolina is the geographic triangle defined by Duke University (Durham), North Carolina State University (NCSU, Raleigh), and the University of North Carolina (UNC-CH, Chapel Hill). Within the triangle are located Research Triangle Park and Raleigh-Durham regional airport. Duke University has about 9,000 students (3,000 graduate, 600 faculty), NCSU has 22,000 students (4,000 graduate, 1,200 faculty), and UNC-CH has 21,000 students (5,000 graduate, 1,600 faculty). All major scientific and engineering disciplines are represented at one or more of the three campuses of the Triangle Universities. Each campus maintains a local computation center as well as using and contributing to the Triangle Universities Computation Center. On each campus there is expertise in large-scale numerical computation, numerical algorithm design and implementation, and in writing and using large scientific and engineering programs.

In the Research Triangle Park area, cooperation among these three vigorous and distinct universities has attracted international attention for several decades. Among the shared ventures are several which provide modern research facilities which would not otherwise be available to our scientists and engineers.

- Research Triangle Park (RTP), begun in 1958, comprises 6300 acres, research and development facilities of 47 national and international corporations and government agencies, 22,000 employees, a payroll in excess of $900 million and a building investment of over $1.25 billion. Areas of research and development include microelectronics, computers, textiles, biotechnology, pharmaceuticals, telecommunications, toxicology, and environmental sciences.

- Research Triangle Institute (RTI) is a free-standing contract research organization created 25 years ago by joint action of the Triangle Universities. Its research activities are organized into ten operating units covering many fields in the social, physical and life sciences, statistics and survey research, chemistry, economics, electronics and systems, engineering, environmental sciences, and toxicology. RTI's staff of almost 1000 occupies 15 buildings on a central campus of 180 acres adjacent to TUCC in RTP. RTI has approximately $43 million in 1984 revenues. RTI is a primary user of the TUCC computing facilities.

- Triangle Universities Computation Center (TUCC) formed in 1965, is now an IBM 3081K24/370-168/FPS-164 installation providing MVS/RJE, MVS/TSO, VM/CMS, WYLBUR, and FPS Fortran service to the Triangle universities through its own three-university network, to about 60 other educational institutions throughout the state, to RTI, MCNC, and to others in and near RTP. TUCC is a not-for-profit corporation, owned and governed by its three founding universities, but operated independently since 1965. The State of North Carolina provides space for TUCC in the Science and

Technology Building in the Research Triangle Park. See Appendix A for a more complete description of TUCC included in TUCC's current proposal to NSF for a link to ARPANET for access to NSF supercomputer centers.

- North Carolina Educational Computing Service (NCECS), formed in 1966, has a staff of 15 providing computing service from suppliers such as TUCC and EDUNET, and technical support (on-site and telephone consulting, workshops, and so on) for educational institutions throughout North Carolina. The NCECS network currently comprises 12 campuses of the University of North Carolina (excluding UNC-CH and NCSU), UNC General Administration, 16 private colleges and universities, 16 community colleges and technical institutes, 13 high schools, and 6 other educational institutions. These institutions serve more than 100,000 students and faculty. NCECS shares the Science and Technology Building with TUCC.

- Triangle Universities Nuclear Laboratory (TUNL), formed in 1967, provides research support with an 8-megavolt Tandem Van de Graaff accelerator and a 15-MeV negative-ion cyclotron. TUNL, located on the Duke University campus, has a faculty of 16, a research and support staff of 20, and 30 graduate students from all three Triangle Universities. As one of the largest university-based nuclear physics laboratories in the nation, TUNL supports an extensive program in basic nuclear physics research using polarized light ions. It is funded by the U. S. Department of Energy.

- Microelectronics Center of North Carolina (MCNC), formed in 1980, has a staff of 100 providing support for microelectronics research. There are additional faculty research positions at each of the Triangle Universities, at North Carolina A&T University in Greensboro, at UNC-Charlotte, and at RTI. These institutions and the State of North Carolina founded MCNC, which moved into a $27 million world-class VLSI design and fabrication research facility in RTP in 1983. A video and data network using microwave, coaxial cable, and fiber-optic components is being implemented to integrate design and research, conferencing, and classroom teaching among the five participating universities, RTI, and MCNC. MCNC operates several Digital Equipment Corporation VAX computers and a CONVEX C-1 in support of its network for VLSI design and design graphics activities.

- In addition, there is in and near Research Triangle Park a growing number of industrial laboratories active in computing and electronics, including General Electric, Sumitomo Electric, Data General, IBM, Mitsubishi Semiconductor, Northern Telecom, and Semiconductor Research Corporation, and Bell Northern Research.

II. RESEARCH AREAS AT TRIANGLE UNIVERSITIES

Scientific research active in the Triangle universities includes the following areas where access to supercomputers is or will be required:

Mathematical Sciences. Research in the mathematical sciences in the Triangle area goes in two primary directions: the first, in which algorithms for solving specific mathematical equations are sought (usually ordinary or partial differential equations), and the second, in which improvement is sought in the computations of linear algebra.

An example of algorithm research is the integration of the Navier-Stokes equations to model flow over an aircraft configuration. Such problems are of great interest in Aerospace Engineering at NCSU. Another example is the solution of very large, very sparse linear systems. In the case of partial differential equations, finite difference or finite element algorithms are used which require a long string of identical floating point operations. This is precisely the type of computation for which vector computers are best suited. However, next-generation vector computers will require a degree of parallelism to overcome single-CPU limitations. The algorithms must be then be changed or adapted to take full advantage of vector-parallel architecture. Thus, meaningful algorithm research requires that a vector-parallel processor be available.

Simulation of Physical Processes. Simulation of a physical process generally replaces a difficult, expensive, or impossible experiment. If an accurate computer model can be obtained for a given process, months of painstaking labor in conducting an experiment may be reduced to a few hours of job preparation, computer time, and output analysis. It is in the area of simulation that computers are presently having the largest impact on research. Without computational simulation our uncertainties prior to first flight of the space shuttle would have been much greater. Other examples of physical processes which yield to simulation approaches and which are currently of great interest in the Triangle Universities are those governed by Navier-Stokes equations for fluid flow, coupled-matrix Schroedinger equations for nuclear collisions and reactions, and Hartree-Fock models for band structures of metals and alloys.

An additional requirement of simulation research is that computer central memory size must increase as processing speed increases. Most presently available supercomputers have 4 megawords or less of central memory, with 1 megaword being most common. In the case of partial differential equations, smaller memories restrict the size problem that can be addressed, regardless of CPU processing speed. These solutions require repetitive sweeps through large fields of discrete values and become I/O bound very quickly if the fields cannot be contained entirely in central memory. This means that if central memory does not increase with processing speed, we can only perform the same solution more quickly, instead of being able to increase the size of problem addressed and/or the resolution of the solution. One example of this requirement for simulation is NASA's National Aerodynamic Simulator project, which has a hardware goal of 1000 MFLOPS sustained operation and 40 megaword central memory with 240 megawords backing store.

Design and Development of Products. Computer-aided design and computer-aided manufacturing (CAD/CAM) have involved the computer in all stages of product development. In CAD, an interactive process is carried out involving many levels of computer capability. These levels may range from graphics packages operational on local minicomputers, to massive finite element stress analysis packages which require Class VI computer capability to bring execution times low enough for interactive use. True interactive CAD may require several cycles through a design process in each interactive session with calls to the stress analysis package during each cycle.

The Microelectronics Center of North Carolina (MCNC) is the focal point for state-of-the-art VLSI design and fabrication activities of five universities and the Research Triangle Institute. MCNC has needs for SPICE (circuit simulation software) to analyze within a few hours circuits of 5,000 to 10,000 transistors. This requires optimization of SPICE for the processor to be used. We know of commercial plans for such optimization for the FPS-164 and for the CRAY. Also at MCNC, research in the synthesis of VLSI circuits will require automated circuit compaction and routers. These programs must manipulate matrices which define a chip's design and are on the order of 1000 x 1000 and 5-30 bytes per feature. Thus, 5-30 megabytes of main memory storage will be required. Electron beam proximity correction research will require analysis of sparse matrices of similar size. Preliminary versions of this software require 4-8 hours per analysis on an IBM 3081.

Computer Graphics Research. High-level research in computer-generated graphics is actively pursued at all three campuses. This research is directed both to improve the graphics tools available to the user and to develop new and innovative techniques for incorporating them into research. A brief description of the major research follows.

UNC at Chapel Hill: Computer graphics research at UNC-CH began in the mid- 1960's with Dr. F. Brooks' interest in human/machine interfaces. It has continued with the first work in "Molecular Graphics" occurring in 1971, involving the graphical modeling of protein and nucleic acid molecules and their interactions. This research has enabled biochemists to understand life processes, suggested experiments and assisted in rational drug design. The first protein molecule whose structure was solved without a physical model was solved here several years ago. Seven specific projects are in process with a five-year schedule.

A complementary project in three-dimensional graphics has resulted in the development of algorithms to provide hidden-surface removal during rotation without additional computation, by use of a preprocessing step. A special data structure contains polygon interrelation information in order that only polygons seen from the selected viewpoint are displayed, at a considerable saving of computing time.

This technique has been applied to a virtual-room computer-graphics display environment, that incorporates 3-D images and operator head tracking to control movement of the display images. The result is simulated real-time motion through the display environment. The virtual-room environment is presently being used to evaluate the architectural design of the new computer science building at UNC-CH and is being used to fit molecular models to electron-density maps. Research is also in progress on high-resolution rendering and modeling techniques. Partitioning of image-generation algorithms for parallel processors is being investigated for real-time production of high-resolution images.

The Molecular Graphics Laboratory at UNC-CH has enjoyed NIH support for a decade. A new $1.9M NIH grant will begin in May 1985 and run for five years. Over the last ten years more than thirty different teams of biochemists from over thirty different institutions have come to work on protein and nucleic acid molecular structure problems. These problems require heavy computation, often requiring Fourier transforms.

NCSU: The Computer Graphics Center is conducting research in airborne and satellite image processing in conjunction with the NCSU Department of Forestry. These efforts include visual analysis of black and white, color, and color infrared imagery. Conventional map form data and imagery are digitized and stored for the purpose of integration with digital image form data. Data are used from a variety of multispectral scanners such as the ocean color scanner, LANDSAT multispectral scanner and thematic mapper, NOAA, VHRR, and AVHRR. These efforts require image processing and graphics processing over large areas, and therefore require advanced computer facilities for more efficient processing and faster turnaround time. For example, just one LANDSAT thematic mapper scene is composed of over 200 megabytes of data. Some of these efforts may require several adjacent scenes to cover the area of interest for several dates.

The Integrated Manufacturing Systems Engineering Institute and the Design Automation Laboratory are developing CAD/CAM software for use in design and manufacturing. Research and improvement of the graphic interface between this software, the engineer, and the end object is an integral part of the Institute's charter. Much of the research concerns the graphical description, display, and manipulation of complex objects.

Duke: Graphics is being used to display the results of reconstructive tomography and for medical imaging at the Duke Medical Center. A research project is underway to reconstruct the original body tissue and structure using data obtained from tomography. The reconstruction can then be analyzed in plane cuts not originally available, and also enhanced for better resolution of the image.

III. RESEARCH PROJECTS REQUIRING SUPERCOMPUTER ACCESS

The demands from the Triangle Universities and research laboratories for advanced scientific computing can be appreciated by noting the sixty different projects identified over the past twelve months as requiring such services. In the list which follows, an asterisk (*) indicates that the researcher is using the FPS-164 at TUCC.

Algorithm Development, Mathematics, Statistics

- Monte-Carlo study of robust randomization tests. [S.K. McNulty, UNC-Greensboro]
- Random-number generators for sampling in multidimensional spaces, with applications to testing VLSI logic gates. [G.S. Fishman and L.R. Moore, Operations Research, UNC-CH]
- Small-eigenvalue problems for very large sparse matrices - comparison of pipeline and MIMD architectures. [M. Patrick, Computer Science, Duke]
- Numerical methods for structural optimization and other large-scale processes. [R. J. Plemmons, Math & Comp. Sci., NCSU]

* Benchmarking supercomputers for scientific applications programs. W.J. Thompson, Physics & Astronomy, UNC-CH]

- Exact minimum Euclidean norm solution to linear least squares problems. [S.K. McNulty, UNC-Greensboro]
- Convergence of some numerical algorithms. [W. Fair, Mathematical Sciences, UNC-Wilmington]
- Bayesian inference with bootstrapping and semi-nonparametric regression. [J. Monahan, Statistics, NCSU]
- Stochastic system simulation. [J.E. Richards, Operations Research, NCSU]
- Optimization of stochastic traffic flow network problems and nuclear power generation models. [T. Reiland, Statistics & Operations Research, NCSU]
- Testing heuristic decision rules over large-scale activity networks. [S. Elmaghraby, Operations Research, NCSU]

* Fitting linear models to large-scale survey data. B. V. Shah, Research Triangle Institute]

* Numerical solution of ordinary differential equations. [H. A. Hamilton, Mathematics, NCSU]

Image processing

* Inverse Monte-Carlo image reconstruction in Emission Computed Tomography. C.E. Floyd, Radiology, Duke]

- Monte-Carlo modeling of scattered-radiation effects in CAT, and three-dimensional image reconstruction in NMR imaging. [F.A. DiBianca, Biomedical Eng., UNC-CH]
- Image enhancement in quasar radio emission. [W.A.

Christiansen, Physics & Astronomy, UNC-CH]
- Optical-spectrum analysis and cross correlations for remote-halo stars. [B.W. Carney, Physics & Astronomy, UNC-CH]
- Processing and display of two- and three-dimensional medical images. [S.M. Pizer, Computer Science, UNC-CH]

Fluid Dynamics, Field Physics

* Computational fluid dynamics; use of Navier-Stokes codes - very stiff partial differential equations. [D.S. McRae, H.A. Hassan, F.R. De Jarnette Mech. & Aerospace Eng., NCSU]
- Lagrangian fluid dynamics on irregular grids; finite-difference algorithms. [W.L. Etheridge, Mathematical Sciences, UNC-Wilmington]
- Compressible-flow calculations for VTOL aircraft engine inlets. [M.A. Boles, Mech. & Aerospace Eng., NCSU]
- Hydrodynamics of the Gulf Stream. [J.M. Bane, Marine Sciences, UNC-CH]
- Three-dimensional modeling of atmospheric and oceanic flows. [Drs SethuRaman and Pietrafesa, Marine, Earth and Atmospheric Sciences, NCSU]
* Ventilation of building structures in planetary boundary layers. [R. Bottcher, Bio. & Ag. Eng., NCSU]
- Radiation transport and fluid flow; computation algorithms. [P. Turinsky and J.M. Doster, Nucl. Eng., NCSU]
- Radiative transfer in plane-parallel media with non-uniform surface illumination. [C. Siewert, Mathematics, NCSU]
- Finite-element analysis of magnetostatic waves in inhomogeneous media. [D. Stancil, Electrical & Computer Eng., NCSU]
- Astrophysical modeling of dense interstellar clouds. [E. Herbst, Physics, Duke]
- Optical properties of stellar atmospheres. [B.W. Carney, Physics & Astronomy, UNC-CH]
- Gravitational radiation spectrum from orbiting black hole collisions. [J.W. York, Physics & Astronomy, UNC-CH]
* Thermal diffusion problems in heat convection unsteady problems. [N. C. Brum, Mech. & Aerospace Eng., NCSU]
* Computation of hyperbolic heat transfer processes. [M. Osizik, Mech. & Aerospace Eng., NCSU]

Structural Analysis and Engineering

- Finite-element modeling for machine design and vibration studies. [T.H. Hodgson, Center for Sound & Vibration, NCSU]
- Modeling of precision machining of metallic components. [T.A. Dow and J.A. Strenkowski, Mech. & Aerospace Eng., NCSU]
- Calculation of forced-response structural vibrations. [A.C. Eberhardt, Mech. & Aerospace Eng., NCSU]
- Synthesis and design of large-scale multivariable feedback control systems. [C.J. Maday, Mech. & Aerospace Eng., NCSU]
- Large-scale computations in structural analysis; sparse-matrix algorithms. [R.J. Plemmons, Computer Science, NCSU]
- Simulation of radioactive waste containment. [R.E. White, Mathematics, NCSU]
- Optimization of nuclear reactor fuel assemblies. [P. Turinsky, Nuclear Eng., NCSU]

* Analysis of shell structures using non-linear finite elements. [A. Gupta, Civil Eng., NCSU]

Microelectronics

- Simulation of VLSI CMOS circuits using SPICE. [R. Fair, MCNC & Duke]
- Monte-Carlo simulation of ion channeling and superlattices. [W-K. Chu, Physics & Astronomy, UNC-CH]
- Ultra-small electronics. [M. Ciftan and R. Brown, Physics, Duke]
- Enhancement of SEM images of microelectronic devices. [F.A. DiBianca and R. Propst, Biomedical Eng., UNC-CH]
- Vectorized two-dimensional compaction of VLSI circuits using VIVID. [Microelectronics faculty at MCNC, Duke, NCSU, UNC-CH]
- Process simulation (PREDICT and SUPREM III) of diffusion and implantation of impurities in semiconductors. [R. Fair, MCNC & Duke]

Condensed Matter Science

* Surface densities of states for solids. K.S. Dy, Physics & Astronomy, UNC-CH]
- Dynamical aspects of phase transitions, condensation, kinetics of crystal growth and surface reactivities. [M. Ciftan and R. Brown, Physics, Duke]
- Phase changes in pure and impure materials, with applications to doping of semiconductors. [R.E. White, Mathematics, NCSU]
* Monte-Carlo modeling of interfaces in electrolytes. J.R. Macdonald, Physics & Astronomy, UNC-CH]
* Band-structure calculations of metals and alloys from ab-initio Hartree-Fock models. L.D. Roberts, Physics & Astronomy, UNC-CH]

Chemistry, Biochemistry, and Biomathematics

* Molecular dynamics of water molecules. M.L. Berkowitz, Chemistry, UNC-CH]
* Self-consistent-field calculations of biomolecular structures. [L.G. Pedersen, Chemistry, UNC-CH]
- Dynamics of fundamental events in protein folding. [L.G. Pedersen, Chemistry, UNC-CH]
- Potential functions and molecular dynamics of biomolecules. [J. Hermans, Biochemistry, UNC-CH]
- Simulation of spike initiation in vestibular nerve fibers. [C.E. Smith, Biomathematics/Statistics, NCSU]
* Simulation of cardiac tissue electrical activation response. [R.C. Barr and R. Plonsey, Biomedical Eng., Duke]
- Numerical simulation of biomedical systems. [J.M. Kootsey, Physiology & Computer Science, Duke]
* Computation of epiturial orientation of polyesthylene oxide crystallization on nylon 6,6. [M. B. Hoyt, Textiles, NCSU]

Atomic and Subatomic Physics

- Relativistic calculations of atomic properties. [K.T. Chung, Physics, NCSU]
- Monte-Carlo analysis of neutron-scattering data from Triangle Universities Nuclear Laboratory (TUNL). [R.L. Walter, Physics, Duke]
- Analysis of high-resolution proton-scattering resonances. [E.G. Bilpuch, Physics, Duke, and G.E. Mitchell, Physics, NCSU]
* Parameter-search codes for optical-model analysis of polarized-nucleon elastic scattering. W.J. Thompson, Physics & Astronomy, UNC-CH]
- Radiative capture in very light nuclei. [A. van Hees and R.Y. Cusson, Physics, Duke]
- Shell model in the continuum and nuclear radiative capture. [S. Cotanch, Physics, NCSU]
* Time-dependent Hartree-Fock calculations of heavy-ion collisions. [R.Y. Cusson, Physics, Duke]
- Quark deconfinement studies of pions produced in high-energy p-p collisions. [W.D. Walker, Physics, Duke]

Mr. **Walgren**. Thank you very much, Dr. Goodwin. We appreciate that.

Let's go on through the rest of the panel and then come back for some discussion. I turn to Dr. Phillips at that point.

Mr. **Phillips**. Thank you, Mr. Chairman, and members of the subcommittee. My name is Don Phillips. I am the executive director of the Government-University-Industry Research Roundtable, sponsored by the National Academies of Sciences and of Engineering and the Institute of Medicine.

On July 22 and 23, 1985, the Research Roundtable, the National Science Board, and the White House Office of Science and Technology Policy sponsored a conference on academic research facilities. I am pleased to be here today to review the proceedings of that conference. To the extent possible, I will attempt to present the full range of views and ideas presented at the meeting. There was no attempt to arrive at a set of consensus recommendations. Also, I must emphasize that I am presenting the views of conference participants, and not those of the conference sponsors.

The purpose of the conference was to provide a setting where representatives from the scientific and engineering communities, universities, State and Federal Governments, industry, and the financial community would come together to design and examine strategies for meeting academic facility needs and for allocating resources for academic research facilities.

The centerpiece of the agenda was six working groups. They included: grants and gifts; alternative sources of finance; partnerships involving industry; university policies and practices; the role of the States; and comprehensive merit evaluation. It was not the purpose of the conference to assess or describe the need for academic research facilities. The need was taken as given. Nonetheless, the conference did provide some general indicators of need.

A review of five limited studies of capital construction and renovation needs for academic research by the conference staff indicated an overall need of at least $1 billion per year for 5 years.

The numbers and range of participants at the conference further indicated a widely felt need. The conference was planned for 130 participants. Final attendance was over 200, including senior officers from universities, industry, Federal and State Governments, and the financial community, Members of Congress and congressional staff, working scientists and engineers, and association representatives.

A few general themes were common to the discussion of specific funding strategies. I will summarize them briefly.

First, Federal and State Governments must play central roles in providing the means for financing new facilities and renovating existing facilities. Industry is an essential partner, but it cannot be expected to be a source of major amounts of funds. Universities, in addition to providing funds, must improve the communication among themselves and with industry about techniques for space management and about effective procedures for facility design and construction.

Second, Federal and State roles include the provision of direct funding for facilities with matching requirements, but go beyond this to include a range of equity and debt financing strategies. A

Federal program of direct funding for facilities would help reduce the university requests to Congress for line-item appropriations for specific facilities.

Three, funding strategies for facilities should include two essential features: one, the ability to meet the needs on a long-term and continuing basis; and two, a review of the technical merits of the facilities and of other factors that are relevant to their establishment and success.

Four, maintaining up-do-date academic research facilities is not simply a university issue. It is an issue with regional and national importance to economic development, industrial competitiveness, national security, and the health of our citizens. The industrial and economic communities must play a central role in documenting these linkages and in communicating them to policymakers and the public.

Finally, the scientific and engineering community must consider bold, new, and more effective approaches to communicating with policymakers and the public about the contributions of scientific and engineering advances to the national well-being. Alliances with a broad range of other groups is necessary.

Several specific strategies for financing facilities were examined. I will describe each briefly. Participants felt that all of these strategies warrant further study and that a diverse set of strategies will be required to meet the facility needs.

The University Research Facilities Revitalization Act of 1985 received general support in principle at the conference. Participants felt that a Federal grant program for facilities must be one component of the overall set of strategies necessary to meet facility needs. Such an approach is necessary for smaller institutions and for institutions seeking to establish new capacity.

The program described in the act would help stem the tide of direct appeals by individual universities to Congress for specific facility appropriations, and it would be effective in leveraging additional funds from the States, industry, and universities. The matching requirement was considered a strong feature of the bill, with the qualification that flexibility be allowed in the ways in which the matching requirement could be fulfilled.

The major concern with the bill was the set-aside provision which it was felt would result in funds being diverted from support for R&D programs to support for R&D facilities. Some participants, however, felt that such a tradeoff was appropriate.

A second concern with the set-aside provision was that it forced all agencies to approach the facility needs in the same manner, whereas the needs vary by discipline, by program, and by institution.

There was broad-based support at the conference for increasing the use allowance in Federal R&D grants and contracts from 2 percent to 5 percent, thereby changing the definition of the useful life of facilities from 50 years to 20 years, a period that the participants felt was much more realistic, especially for the inner workings of an up-to-date research facility.

The advantages of this approach are, one, the facility support is linked with scientific and engineering programs that have passed the test of merit review; and two, the universities are provided with more adequate amounts of funds to maintain facilities and to repay loans used for facility construction and renovation.

Participants agreed, however, that such an approach does not meet the needs of institutions with a small R&D base and institutions seeking to establish new research capacity.

Robert Sproull, president emeritus of the University of Rochester, and a member of the Roundtable Council, proposed that a charge for rent of research space be made an explicit component of Federal R&D contracts and grants with universities. This approach has the same advantages and disadvantages as the one above.

Tax-exempt financing for research facilities was considered along the lines of a proposal prepared by David Clapp of Goldman-Sachs & Co. He proposed the establishment of a nonprofit corporation to provide loans at the lowest possible interest rate for the construction and renovation of academic research facilities. The central elements of the corporation would be a trust fund provided by a one-time congressional appropriation, the issuance of tax-exempt bonds, and a financial guarantee on the tax-exempt debt.

Positive features of the proposal are: the centralization of tax-exempt facility financing, with resultant reduced transaction costs; a high credit rating, and resultant low interest rates on the tax-exempt bonds; additional reduction of interest rates by an amount of subsidy derived from income earned on the trust fund, which is used over and over; and the review of the loan request for technical merit.

The above three pay-as-you-go approaches to facilities funding have several features in common. One, they provide ongoing mechanisms for meeting facility needs. Two, they require universities to make upfront commitments of funds for facilities and to use facility use charges in R&D grants and contracts and other income to pay off the capital and interest. And three, these mechanisms will result in a tradeoff of program funds for facilities funds unless new funds are added to the R&D system or there are decreases in elements of the indirect cost pool other than facility use charges.

Facilities meet both State and national needs and thus the participants called for a State-Federal partnership for support of research facilities. Long-term Federal programs with matching requirements were considered to be one effective approach to ensuring continuing State contributions. In general, however, it was felt that much more effort must be devoted to involving the States in discussions for meeting facility needs and in discussions of the appropriate guidelines for an endurinng partnership.

The participants viewed State government-university-industry partnership as especially helpful in planning for facility needs and building the case for the importance of the facilities and in obtaining the necessary State financial support.

A portion of the conference was devoted to an examination of the appropriate procedures for evaluating facility proposals and allocating the funds available. Most important in the view of the participants is that there be an organized process with the criteria clear to everyone. The majority of participants agreed that this process will include an evaluation on a case-by-case basis of the technical merits, local capabilities and aspirations, and other factors that impinge on the ultimate success of each individual facility proposal. Such other factors include social, economic, and political considerations. The phrase "comprehensive merit evaluation" was used to describe this process.

A minority of participants, while agreeing that the process for facility proposal evaluation would operate in this manner, felt that the phrase peer review should be maintained.

In conclusion, the conference illustrated clearly that the research community is faced with difficult choices. For example, choices between funds for R&D programs and for research facilities, choices between equity and debt financing for facilities, choices about the degree of risk to be assumed by the universities, by industry, and by Government for facility funding.

For its part, the Research Roundtable will seek to contribute to the resolution of these choices by developing in greater detail the strategies presented at the conference, perhaps even to the extent of trying some of the approaches with a few universities and Government agencies. With a better understanding of the operational details of the strategies and of their varying impacts on the different components of the R&D system, it should be easier to put together the package of multiple approaches to facility funding that everyone feels is needed.

Thank you.

[The prepared statement of Mr. Phillips follows:]

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

Testimony by Don I. Phillips
on
University Research Facilities
October 24, 1985

Mr. Chairman and members of the Subcommittee. My name is Don Phillips. I am the Executive Director of the Government-University-Industry Research Roundtable, sponsored by the National Academies of Sciences and of Engineering and the Institute of Medicine. On July 22-23, 1985, the Research Roundtable, the National Science Board, and the White House Office of Science and Technology Policy sponsored a conference on Academic Research Facilities. I am pleased to be here to review the proceedings of that conference. To the extent possible, I will attempt to present the full range of views and ideas presented at the conference. There was no attempt to arrive at a set of consensus recommendations. Also, I must emphasize that I am presenting the views of conference participants, and not those of the conference sponsors.

Conference Objectives

The purpose of the conference was to provide a setting where representatives from the scientific and engineering communities, universities, state and federal governments, industry, and the financial community would come together to design and examine strategies for meeting academic facility needs and for allocating resources for academic research facilities. The conference was organized by a committee chaired by Dr. John Moore, then a member of the National Science Board and now the Deputy Director of the National Science Foundation. The committee included representatives from all the sectors. A list of the members is included as Attachment I.

The conference was a working session intended to produce concrete suggestions for meeting facility needs. The centerpiece of the agenda, therefore, was six working groups: Grants and Gifts; Alternative Sources of Finance; Partnerships; University Policies and Practices; Role of the States; and Comprehensive Merit Evaluation. A copy of the complete agenda is included as Attachment II. I am submitting for the record the set of background materials used for the working group deliberations.

A full report on the conference is being prepared and will be shared with the Subcommittee. My purpose today is to extract some of the highlights of the proceedings that may be useful to the Subcommittee as it considers H.R. 2823, The University Research Facilities Revitalization Act of 1985. These highlights are organized into four sections: Need for Facilities; General Observations; Funding Strategies; and Comprehensive Merit Evaluation.

Need

It was not the purpose of the conference to assess or describe the need for academic research facilities; the need was taken as a given.

Nonetheless, the conference did provide some general indicators of the need. First, a review of five limited studies of capital construction and renovation needs for academic research by the conference staff indicated an overall need of at least $1 billion per year for five years. Second, the National Science Board began studying the issue in June, 1984, and in February, 1985, officially recommended the convening of a conference. The Research Roundtable reached similar conclusions at about the same time. And, the White House Science Council has a special panel studying the health of universities, which includes an examination of how to meet the needs for academic research facilities. Finally, the numbers and range of participants at the conference indicate a widely felt need. The conference was planned for 130 participants; final attendance was over 200, including senior officers from universities, industry, federal and state governments, and the financial community, members of Congress and congressional staff, working scientists and engineers, and association representatives.

General Observations

A few general themes were common to the discussions of specific funding strategies. They were:

o Federal and state governments must play central roles in providing the means for financing new facilities and renovating existing facilities. Industry is an essential partner, but it cannot be expected to be a source of major amounts of funds. Universities, in addition to providing funds, must improve the communication among themselves and with industry about techniques for space management and about effective procedures for facility design and construction.

- Federal and state roles include the provision of direct funding for facilities, with matching requirements, but go beyond this to include a range of equity and debt financing strategies. A federal program of direct funding for facilities would help reduce the university requests to Congress for line-item appropriations for specific facilities.

- Funding strategies for facilities should include two essential features: (1) the ability to meet the needs on a long-term and continuing basis and (2) a review of the technical merits of the facilities and of other factors that are relevant to their establishment and success.

- Maintaining up-to-date academic research facilities is not simply a university issue. It is an issue with regional and national importance to economic development, industrial competitiveness, national security, and the health of our citizens. The industrial and economic communities must play a central role in documenting these linkages and in communicating them to policy-makers and the public.

- The scientific and engineering community must consider bold, new, and more effective approaches to communicating with policy-makers and the public about the contributions of scientific and engineering advances to the national well-being. Alliances with a broad range of other groups is necessary.

Funding Strategies

Several specific strategies for financing facilities were examined at the conference. I will describe each briefly. The participants felt that all of these strategies warrant further study and that a diverse set of strategies will be required to meet the facility needs.

1. H.R. 2823, The University Research Facilities Revitalization Act of 1985. The University Research Facilities Revitalization Act of 1985 received general support, in principle, at the conference. Participants felt that a federal grant program for facilities must be one component of the overall set of strategies necessary to meet facility needs. Such an approach is necessary for smaller institutions and for institutions seeking to establish new capacity. (The strategies listed below would not be effective for such purposes.) The program described in the Act would help stem the tide of direct appeals by individual universities to Congress for specific facility appropriations, and it would be effective in leveraging additional funds from the states, industry, and universities. The matching requirement was considered a strong feature of the Bill, with the qualification that flexibility be allowed in the ways in which the matching requirement could be fulfilled.

The major concern with the Bill was the set-aside provision, which, it was felt, would result in funds being diverted from support for R&D programs to support for R&D facilities. Some participants, however, felt that such a trade-off was appropriate. A second concern with the set-aside provision was that it forced all agencies to approach the facility needs in the same manner whereas the needs vary by discipline, by program, and by institution.

2. Increase the Facility Use Allowance in Federal R&D Grants and Contracts from Two Percent to Five Percent. One component of indirect costs or pooled costs in federal R&D grants and contracts to universities is a use allowance or depreciation on buildings in which the research is carried out. The standard allowable use charge is two percent per year. A university may include an alternative depreciation rate if it is fully documented. It is also possible to include within pooled costs, with permission of the agency sponsoring the research, the interest on loans taken by the university to construct the building in which the research is being carried out.

There was broad-based support at the conference for increasing the use allowance from two percent to five percent, thereby changing the definition of the "useful life" of facilities from 50 years to 20 years—a period that the participants felt was much more realistic especially for the inner workings of an up-to-date research facility.

The advantages of this approach are that (1) the facility support is linked with scientific and engineering programs that have passed the test of merit review and (2) the universities are provided with more adequate amounts of funds to maintain facilities and to repay loans used for facility construction and renovation. Participants agreed, however, that such an approach does not meet the needs of institutions with a small R&D base and institutions seeking to establish new research capacity.

3. Explicit Rent Charges in Federal R&D Grants and Contracts to Universities. Robert Sproull, President Emeritus of the University of Rochester and a member of the Roundtable Council, proposed that a charge for rent of research space be made an explicit component of federal R&D contracts and grants to universities. The elements in the rent calculation would include: (1) building depreciation and obsolescence; (2) routine maintenance; (3) security; (4) grounds care for grounds immediately attached to the building; (5) parking lot costs for spaces required by people associated with the building space; and (6) heat, power, light, and "pure water" charges. Comparisons would be made with laboratory and office space of comparable quality in the same geographic region as part of the negotiations leading to an agreed upon rent-per-square foot.

This approach has the same advantages and disadvantages as the one above.

4. Tax-Exempt Financing for Research Facilities. Tax-exempt financing for research facilities was considered along the lines of a proposal prepared by David Clapp of Goldman Sachs and Company. He proposed the establishment of a nonprofit corporation to provide loans at the lowest possible interest rates for the construction and renovation of academic research facilities. The central elements of the corporation would be a trust fund, provided by a one-time congressional appropriation; the issuance of tax-exempt bonds; and a financial guaranty on the tax-exempt debt.

The positive features of the proposal are the centralization of tax-exempt facility financing with resultant reduced transaction costs, a high credit rating and resultant low interest rates on the tax-exempt bonds, additional reduction of interest rates by an amount of subsidy derived from income earned on the trust fund, which is used over and over, and the review of the loan requests for technical merit.

The above three pay-as-you-go approaches to facility funding have several features in common: (1) they provide on-going mechanisms for meeting facility needs; (2) they require universities to make up-front commitments of funds for facilities and to use facility use charges in R&D grants and contracts and other income to pay off the capital and interest; and (3) these mechanisms will result in a tradeoff of program funds for facility funds unless new funds are added to the R&D system or there are decreases in elements of the indirect cost pool other than facility use charges.

5. The Roles of the States. States are responsible for the general support of public institutions of higher education, and in the views of the conference participants this responsibility must include support for academic research facilities. These facilities meet both state and national needs, and thus the participants called for a state-federal partnership for support of research facilities. Long-term federal programs with matching requirements were considered to be one effective approach to ensuring continuing state contributions. In general, however, it was felt that much more effort must be devoted to involving the states in discussions of strategies

for meeting facility needs and in discussions of the appropriate guidelines for an enduring partnership. The participants viewed state government-university-industry partnerships as especially helpful in planning for facility needs, in building the case for the importance of the facilities, and in obtaining the necessary state financial upport.

States were encouraged to consider a wide range of techniques for financing research facilities including general fund appropriations, leveraging contributions from industry, issuance of bonds, earmarked taxes, lease-purchase agreements, dedicated tuition payments, user fees, and indirect cost recovery management.

6. Additional Strategies. Several additional strategies were mentioned during the Conference. They are:

- Extend the tax credit for equipment donations to the donation of funds for facilities.
- Establish research condominiums on campuses with some space purchased/leased by the university and some space purchased/leased by industry.
- Request the Secretary of Commerce to carry out a study of the impact of deteriorating research facilities on U.S. international competitiveness.
- Request the National Science Foundation to carry out a study of

the current status of academic research facilities.

Comprehensive Merit Evaluation

A portion of the conference was devoted to an examination of the appropriate procedures for evaluating facility proposals and allocating the funds available. A background paper on this subject concluded that the allocation process for research facilities is not exclusively the result of a competition among proposals for identical facilities. Rather, the process is the result of an evaluation, on a case-by-case basis, of the technical merit, local capabilities and aspirations and other factors that impinge on the ultimate success of each individual facility proposal. Such other factors include social, economic and political considerations. For these reasons, the phrase "comprehensive merit evaluation" best describes the process for review of research facility proposals.

The majority of participants agreed with this conclusion as long as technical review was the initial screening procedure in the comprehensive merit evaluation process. A minority of participants, while agreeing that the process for facility proposal evaluation operated as described above, objected to the use of the phrase "comprehensive merit evaluation." They felt that the phrase "peer review" should be maintained.

Most important, in the view of the participants, is that there be an organized process, with criteria clear to everyone, for the evaluation of proposals for facility construction and renovation.

Next Steps

Discussion of the University Research Facilities Bill and the other strategies presented at the conference, at a time when everyone agrees that increased budgets for R&D are unlikely, illustrated clearly to the participants that the research community is faced with difficult choices—for example, choices between funds for R&D programs and for research facilities, choices between equity and debt financing for facilities, choices about the degree of risk to be assumed by the universities, industry, and government for facility funding. For its part, the Research Roundtable will seek to contribute to the resolution of these choices by developing in greater detail the strategies presented at the conference, perhaps even to the extent of trying some of the approaches with a few universities and government agencies. With a better understanding of the operational details of the strategies and of their varying impacts on the different components of the R&D system, it should be easier to put together the package of multiple approaches to facility funding that everyone feels is needed.

Attachment I

Planning Group
Working Conference on Strategies for Supporting Academic Research Facilities

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‡Although the Group does not include a member of Congress, Congressman George Brown and other members have agreed to work with the Group.

04/24/85

Attachment II

ACADEMIC RESEARCH FACILITIES
Financing Strategies and Evaluation Procedures

July 22 - 23, 1985

Lecture Room
NATIONAL ACADEMY OF SCIENCES
2101 Constitution Avenue, N.W.
Washington, D.C.

NATIONAL SCIENCE BOARD · OFFICE OF SCIENCE AND TECHNOLOGY POLICY
NATIONAL ACADEMY OF SCIENCES · NATIONAL ACADEMY OF ENGINEERING
GOVERNMENT-UNIVERSITY-INDUSTRY RESEARCH ROUNDTABLE

CONFERENCE AGENDA

MONDAY, JULY 22

8:30 **Registration,** Entry to NAS Lecture Room

9:00 **Welcoming Remarks,** *Dale R. Corson,*
Chairman, Research Roundtable

9:15 **Overview,** "The Search for Solutions" *Roland W. Schmitt,*
Chairman, National Science Board

9:45 **Concurrent Working Groups,** Session I,
For listing of sessions see back of brochure

11:00 **Comprehensive Merit Evaluation and Research Facilities,** Panel Discussion

Moderator: *Dale R. Corson*

Panel Members: *Bernadine Healy,* Deputy Director,
Office of Science and Technology Policy

Alvin Kwiram, Chairman,
Dept. of Chemistry, Univ. of Washington

Peter Likins, President,
Lehigh University

Buddy MacKay, Member,
U.S. House of Representatives

Alvin Trivelpiece, Director,
Office of Energy Research,
Department of Energy

12:30 **Lunch,** NAS Refectory

1:30 **Working Groups,** Session II

5:30 **Cocktail Reception,** Great Hall

Evening Complete Working Group reports as needed

TUESDAY, JULY 23

8:15 **Reports from Working Groups**

Moderator: *Dale R. Corson*

8:15 - Reports

Working Group Moderators: *Edward Bloustein, David C. Clapp, William F. Massy, Kenneth Pickar, Thomas Stelson, Robert Wise, William Wells*

9:15 - Response to Working Group Reports, Panel Discussion

Panel Members: *The Honorable Don Fuqua*, Member,
U.S. House of Representatives

The Honorable George Darden, Member,
U.S. House of Representatives

10:00 - Questions and Comments from the Audience

10:30 **Break**

10:45 **Reports from Working Groups,** continued

Moderator: *Dale R. Corson*

10:45 - Reports

11:15 - Questions and Comments from the Audience

12:00 **Observations, Conclusions, and Next Steps,** *Roland W. Schmitt, Bernadine Healy, and Dale R. Corson*

1:00 **Adjourn**

WORKING GROUPS

1. **Grants and Gifts** (Federal, state, private sector; types, including matching, formula, block, set-asides, etc.)

   Moderator: *Edward Bloustein*, President, Rutgers University

2. **Alternative Sources of Finance** (Loan guarantees, interest payments via grants, indirect cost recovery, borrowing, credit rating improvements, tax incentives, etc.)

   Moderators: *David C. Clapp*, Partner, Goldman Sachs and Company

   William F. Massy, Vice President for Business and Finance, Stanford University

3. **Partnerships** (Forms and types; possible cooperative arrangements, including inter-corporate, government-industry-foundation, inter-university; combinations with borrowing, grants, etc.)

   Moderator: *Kenneth Pickar*, Research and Development Manager, Electronics Laboratories, General Electric Company

4. **University Policies and Practices** (Facility design; causes of obsolescence; depreciation obsolescence practices; maintenance, refurbishment v. replacement; restraint; etc.)

   Moderator: *Thomas Stelson*, Vice President for Research, Georgia Institute of Technology

5. **Role of the States** (Direct support; financial packages; debt; tuition charges; relations with private universities; economic development centers; etc.)

   Moderator: *Robert Wise*, Assistant for Policy and Planning, Office of the Governor, State of Arizona

6. **Comprehensive Merit Evaluation for Facilities** (Present practice; alternatives; confidence-building measures; differentiation from individual research grants; etc.)

   Moderator: *William Wells*, Professor, Dept. of Management Science, George Washington University

Mr. Walgren. Thank you very much.

I think the better choice at this point would be to suspend and respond to the rollcall on the floor and then come back to the other witnesses. So if you will pardon the interruption, we will be back in 15 minutes, no more than 15 minutes.

[Recess.]

Mr. Walgren. The subcommittee will come back to order.

I would ask Dr. Sherman to proceed.

Mr. Sherman. Thank you, Mr. Chairman.

I speak both as the vice president for the American Association of Medical Colleges but also as an individual who has had some experience with the construction program because of my former association with NIH and what we believed to be, by every account, a very successful health research facilities construction program which ran there for approximately 12 years in the late 1950's and early 1960's.

First of all, we would like very, very much to compliment you and Chairman Fuqua and your colleagues for both raising this issue to such a degree of visibility and, second, to provide an opportunity through extensive hearings in order to lay out the issues and to gain as much information about the resolution of some of the problems that these issues raise that this approach offers. For that reason, we are very grateful both for the opportunity to testify and for the interest that you and your colleagues have shown in the subject.

As I believe you are aware, sir, from your involvement in Mr. Waxman's subcommittee, our association represents all the accredited medical schools in our country, most of the teaching hospitals and the professional associations representing our faculties who do, in collective terms, almost 60 percent of the Nation's biomedical research. Therefore, we have a very keen interest in subjects of this nature, and in particular, this one on facilities and their renovation as well as their replacement, where necessary.

I would like to point out one difference, recalling the days of the earlier construction program at NIH; namely, that that program emphasized, in addition to such replacement as was necessary, an expansion. Yet this bill in many of its respects will profit, I think, from the testimony of Dr. Wyngaarden and others from the NIH as to the experience of that earlier and successful program.

Although I speak only for the medical school community today, I would like to emphasize that it is certainly our belief that the problem which you have highlighted is indeed a widespread and national one affecting all areas of science, and unless that scientific effort continues to be productive, not only will certain segments of our population be affected, such as in health, but the economic concerns being addressed by the Congress in a number of different ways may well be overlooked as to the contributions that a strong scientific effort can make.

We may be in some sense speaking to a paradox in our statement today because, while we emphasize the need for additional funds from some source, particularly the Federal Government, to correct the longstanding general deterioration of the facilities package, we also speak to the need for data. This is not as incongruous as it sounds, because that data, we believe, is badly needed in order to fine tune whatever process is ultimately provided by the Congress in correcting this situation.

In other words, it is our belief that particularly in the health field, a high degree of flexibility is required based on more adequate data than is presently available, so as to be certain that the funds are used most effectively and efficiently.

I have, very briefly, six areas of the bill on which I would like to comment. The first has to do with the 10-percent minimum allocation, generally speaking. It is our belief that this, while desirable in terms probably of absolute amount, nonetheless represents the type of inflexibility which we believe would be better corrected through separate, either permanent or time-limited, authority with appropriate dollar and time limitations.

That, we believe seriously, is a better approach than the 10-percent allocation because of the changing nature over a period of time and the uncertainty in the future, given the deficit situation and the level of Federal appropriations.

Second, we question seriously whether or not the 15-percent reservation for small institutions is again necessary and the best way to accomplish an obviously desirable objective. From the experience in the Health Research Facilities Construction Program, there was an allocation of funds through a peer-review process that both gave the assurance of quality and yet gave evidence that smaller institutions—smaller in the sense of the extent of their research intensity—could compete successfully under an open-ended rather than a restricted ceiling. Therefore, we would suggest that that approach be changed.

Third, the eligibility of institutions, we would suggest, ought to be broadened so as to recognize the important contribution that many of the research-oriented teaching hospitals make, especially in the area of clinical investigation, and would hope that the eligibility could be broadened to recognize those university-affiliated institutions.

The fourth area has to do with the eligibility as far as costs are concerned, and we would suggest the program could be made much more efficient and effective by recognizing total project costs so as to include items of fixed equipment. We are convinced that is the case since this would assure to a greater extent that when the project is completed, there is a facility in which research can readily and immediately be conducted.

Our fifth consideration has to do with the availability of these funds. Again harking back to the experience with the research facilities construction program at NIH, it was our experience that the funds were best used when they were available until expended rather than reverting at the end of the fiscal year. This was because many excellent institutions, both large and small, received tentative awards on the basis of excellent proposals, but then found that they had difficulty in obtaining the matching money. So that it was possible within the portfolio of approved proposals to move around the moneys and the proposals to take advantage of those that were immediately ready to go while the others waited until the matching money they were required to raise was assured.

Last, we would suggest strongly the introduction of a right-of-recovery provision, so that the Government and the public would be assured that the facility provided under this proposed program would indeed be used for the purposes intended. This could be introduced in a number of different fashions, but would assure the program operators as well as the Congress that indeed research was the primary purpose at the beginning as well as at the end of the required period.

I will close my remarks there, Mr. Chairman. I would be willing to answer any questions, and also express our desire as well as our willingness to work with you and other members of the committee as the legislation proceeds.

[The prepared statement of Mr. Sherman follows:]

STATEMENT

OF THE

ASSOCIATION OF AMERICAN MEDICAL COLLEGES

on

H.R. 2823

"The University Research Facilities Revitalization Act of 1985"

The Association of American Medical Colleges (AAMC) appreciates this opportunity to submit its views on H.R. 2823, "The University Research Facilities Revitalization Act of 1985." The Association represents the nation's 127 accredited medical schools, over 430 teaching hospitals, and 79 academic and professional societies, which together comprise the whole complex of individual organizations and institutions charged with the undergraduate and graduate education of physicians.

Submitted to the Science and Technology Subcommittee on Science, Research, and Technology on October 24, 1985.

aamc

Association of American Medical Colleges / One Dupont Circle, N.W. / Washington, D.C. 20036 / (202) 828-0525

The Association's membership has long been deeply committed to participating in the nation's biomedical and biobehavioral research effort; typically, in Fiscal Year 1984, AAMC institutions performed just under 58 percent of all the extramural research funded by the National Institutes of Health (NIH). Thus, the AAMC has a major interest in H.R. 2823, with a more parochial stake in the scope and design of the construction program ultimately administered by DHHS. First, general comments will be presented, followed by specific recommendations on various provisions of H.R. 2823, or the "Fuqua bill" as it is more commonly known.

The Association holds as axiomatic the principle that society benefits through a vigorous research enterprise in the biomedical sciences. The basic scientific knowledge produced by this research not only mitigates the ravages of death, disease, and disability, but also yields important spin-off benefits to the economy, through subsequent application to hundreds of different products and processes. Since the end of World War II the Federal government has recognized the importance of biomedical research, and awarded substantial funds to colleges and universities through the NIH. As a consequence, an unparalleled university-based biomedical research enterprise has developed, with the academic community regularly performing about 75 percent of NIH's extramural research, equivalent to 26 percent of the total Federal research basic effort.

Recognizing the substantial national benefits that accrued from NIH-supported research projects at universities and colleges across the country, and the inability to expand that effort for lack of sufficient facilities, the Federal government in the late 1950's entered into a partnership with the university community to develop a biomedical research infrastructure that was adequate to house and expand that research, and thereby promote the recruitment and retention of topflight talent. The government agreed that universities simply could not afford to bear the total cost of the facilities needed to house a biomedical research enterprise of the size that the potential public benefit warranted.

The principal vehicle employed by the Congress and NIH to remodel and expand the nation's university biomedical research plant capacity was the Health Research Facilities Act (HRFA) of 1956. Under this legislation, the NIH, from FY 1957 to FY 1969, expended $473 million to fund 1,482 projects; 407 different public and non-profit institutions received HRFA awards on a 50-50 matching basis, with the match ultimately leveraging $632 million, 33 percent more than required by statute.

HEW's engagement in university research facility construction was at that time common for a Federal agency. In the 1950's and 60's, some 20 separate statutes authorizing facilities programs were enacted, and universities were able to reconstruct and expand research laboratories, financed in part with Federal support, on a significant scale. However, by 1970, most of these construction initiatives were phased out. Now, after almost two decades of neglect, the nation's complement of research facilities has deteriorated to a considerable degree. Moreover, scientific progress in the interim has rendered much of the space obsolete for modern research. Hence, the current need for Federal support.

While there is a clear need for major renewed Federal investment in university research laboratory construction and renovation, estimates about the precise amount universities and colleges require in order to sustain their research programs differ widely. However, it is generally conceded that university facilities needs exceed the scope of any foreseeable Federal initiative. This stark reality in no way lessens the imperative for obtaining comprehensive data on institutional research facility construction needs, broken down by type of institution, field of need, nature of construction needs, current construction plans, expected cost of construction, etc. — information essential for the legislature and agencies to target resources most efficiently. It is regrettable that the Administration has repeatedly ignored Congressional mandates and intentions by refusing to comply with statutory or report language requesting assessments of university facility requirements. The Association heartily commends the provisions of H.R. 2823 that charge the National Science Foundation (NSF) with initially collecting information on, and then regularly monitoring, the particular research facility requirements of the nation's colleges and universities.

The desperate need to revitalize research facilities accounts, at least in part, for the recent efforts by individual universities to obtain facilities funding by by-passing established agency funding processes and securing awards directly from the Congress. In Fiscal Years 1983 and 1984, 15 universities received funding totalling over $100 million for facilities through this process. In some cases, the requests had been previously disapproved by awarding agencies; in others, detailed proposals for facilities projects had not been revealed, even as the Congress was appropriating funds for them. But frequently, no program existed in which institutions with a space crisis could even have competed. Establishment of Federal university research facility programs should also lead to the application of rigorous review procedures as a precondition for Federal contribution to a facility project. Moreover, traditional peer-review processes, an essential component of the Federal funding of biomedical science, would be reaffirmed and strengthened.

AAMC's Position on H.R. 2823

The AAMC wholeheartedly supports the central thrust of the Fuqua bill, which is to establish research facility construction programs for universities and colleges within each of the 6 largest Federal research funding agencies. A major Federal initiative is the only realistic means to reverse the erosion of the nation's academic research infrastructure, and the longer this formidable task is delayed, the more expensive it will ultimately become. The AAMC endorses the long-term commitment inherent in the bill. However, the AAMC believes that from the point of view of NIH-supported biomedical and behavioral research, H.R. 2823 would be even more effective if certain alterations were made. Therefore, several specific changes, summarized in bold print at the end of each relevant topic, are suggested.

Funding Mechanism

H.R. 2823 requires a minimum annual allocation of 10 percent of each agency's budget for university and college research and development (R & D) to be dedicated to its university facilities program, except in those years in which aggregate university R & D appropriations drop. The proposed funding mechanism explicitly couples investment in the construction of university facilities with other research expenditures; it also guarantees substantial funding for the construction programs. However, its automaticity precludes any flexibility, judgement or discretion on the magnitude of facility funding, either for the Congress or the administering agency. The tithing of R & D budgets would also render the Congress unable to devote increased resources for non-facilities R & D in areas of particular need, without simultaneously increasing expenditures for university facilities.

H.R. 2823's policy of requiring agencies to spend a minimum fixed percentage of their academic R & D budgets for research facility construction is generally undesirable, but it is doubly risky given the absence of comprehensive data on university facilities needs, broken down by discipline and type of institution. It is almost certainly the case that each agency's university R & D constituents have different construction needs that are best accommodated through the annual appropriations process. While the general deterioration in the infrastructure for research and the need for overhaul are obvious, there are instances, particularly during an era in which the prospects for the Federal funding of research are not overly promising, in which scientists may well be willing to continue to work in less than ideal facilities for a few years until the fiscal crisis passes, rather than see their research support diverted to construction. AAMC's concern over the funding mechanism used by H.R. 2823, despite the bill's provision to protect the research base in the event that appropriations decrease, is therefore partially due to the fact that it may well pit university researchers — who are understandably preoccupied with obtaining maximum research project support — against administrators -- who must support the research environment. This phenomenon could have unfortunate political consequences for the bill.

Consequently, the AAMC endorses adoption either of broad, permanent construction authority for HHS, or of time-limited authority with authorization ceilings for the program. The ceilings could initially be set at an appropriate level, perhaps 10 percent of academic R & D, and later adjusted as data or need become more definite. The duration should be for a period of at least ten years. Either of these two approaches would give the Appropriations Committees the flexibility to meet the particular needs of each agency and rely on latest estimates of need.

If the appropriate Committee decides against the use of either permanent or temporary legislative authority for HHS construction projects, the Association recommends that the magnitude of the minimum construction allocation somehow be made contingent upon the initial incremental facilities appropriation. For example, the percentage to be reserved for construction might be set at the ratio the FY '87 appropriation bears to that agency's academic R & D, rather than as a flat 10 percent. This would insure that university R & D budgets are not unduly taxed by the program.

The Current Funding Formula for University Facilities Projects Should Be Dropped, and Permanent Legislative Authority or Regular Authorizations Employed Instead.

The 15 Percent Reservation for Institutions With Smaller R & D Budgets

H.R. 2823 requires that at least 15 percent of the funds reserved for each agency's construction program be awarded to institutions that received R & D awards below a specified threshold during the previous two years. This provision addresses concerns about the ability of non-research-intensive universities to successfully compete for their proportional share of available construction funds. However, the aim of H.R. 2823 to revitalize the existing academic research infrastructure cannot be achieved if construction funds are diverted from institutions currently conducting the vast majority of Federal research. The AAMC fully expects that the 283 academic institutions that received less than $5,000,000 in NIH support in FY '85, totalling $223 million, or about 7 percent of NIH's academic extramural budget, would receive at least their fair share of facilities support from an HHS program developed under by H.R. 2823. This conviction is buttressed by the fact that, as mentioned above, some 407 different institutions received awards under the open competition of the Health Research Facilities Act.

The Allocation of 15 Percent of HHS's Research Facilities Program to Institutions with Smaller R & D Budgets Should Be Deleted.

Eligible Institutions

A number of university-affiliated hospitals conduct significant amounts of research and need research facility renovation and replacement as sorely as do traditional academic facilities. Adding these entities to the program would ensure that the program meets all university-based research needs without unduly expanding or diluting the focus of the program.

Program Eligibility Should Be Extended to University-Affiliated Hospitals.

Eligible Costs

Section 3(c) of H.R. 2823 authorizes construction funds for the "cost" of the replacement or modernization project. The AAMC recommends that this language be expanded to include "total project cost," to allow an agency to include fixed equipment and major movable research equipment that are part of the research facility to be treated as part of the total project cost. A university or college could then meet a portion of its required match by providing fixed or moveable research equipment for a facility. The change will also help to ensure that facilities will be properly equipped upon completion of modernization projects.

Grant Eligibility Should Be Expanded to Include "Total Project Cost."

Availability of Construction Funds

H.R. 2823 contains no authority for agencies to retain construction funds beyond the expiration of a fiscal year. Such authority is important because the initiation of an approved facilities project is often delayed by many uncertainties following peer-review approval of a construction application. Until these are resolved, an agency cannot be sure whether the project is viable and must therefore delay awarding funds. An example that might be cited is the time that it takes for an institution to secure matching funds, once its facility application is approved. Language making agency funds "available until obligated and expended" is especially critical if the 10 percent set-aside is included in the final bill, since as currently drafted it is not calibrated to each agency's academic universe.

Language Should Be Added That Allows Construction Funds to Remain Available Until Expended.

Federal Right-of-Recovery Provisions

Legislation authorizing Federal facilities programs has generally included statutory language that specifically authorizes the government to recover its share of a facilities project if, with a de minimus exception, the facility is no longer used as originally intended. In the case of H.R. 2823, recovery would be warranted if a facility were no longer housing research, or if a university or its affiliate no longer controlled a building constructed with Federal funds. It is reasonable to require a facility to meet these criteria for ten years after the facility has been replaced or renovated. Finally, the Federal recovery should be set at the ratio Federal funds bore to the original construction costs of the facility, compared to current value of the facility.

Right-of-Recovery Language Should Be Added to Ensure Funds are Used for Originally Intended Purposes.

Summary of Position

In summary, the AAMC recommends that:

- The Current Funding Formula for University Facilities Projects Should Be Dropped, and Permanent Legislative Authority or Regular Authorization Employed Instead.
- The Allocation of 15 Percent of HHS's Research Facilities Program to Institutions with Smaller R & D Budgets Should Be Deleted.
- Program Eligibility Should Be Extended to University-Affiliated Hospitals.
- Grant Eligibility Should Be Expanded to Include "Total Project Costs."
- Language Should Be Added That Allows Construction Funds to Remain Available Until Expended.
- Right-of-Recovery Language Should be Added to Ensure Funds are Used for Originally Intended Purposes.

The Association appreciates this opportunity to comment on this important legislation and looks forward to working further with the Subcommittee as H.R. 2823 moves forward.

Mr. **Walgren**. Thank you very much. We appreciate that.

Dr. Garin?

Mr. **Garin**. Thank you, Mr. Chairman. My name is David Garin. I am the treasurer of the National Coalition for Science and Technology. NCST is a nonpartisan, nonprofit coalition of individuals, professional associations, and R&D-intensive organizations active in science, engineering, and technology. I am also associate professor of Chemistry at the University of Missouri, St. Louis.

On my left is Dr. Phillip Speser, who is the executive director of NCST, who will be available to help answer any questions.

I want to thank you for the opportunity to testify here today. The testimony was developed with the assistance of several members of the NCST executive committee and as such may not represent the views of specific members or advisers.

Mr. Chairman, and members of the committee, the legislation which you have before you is long overdue. Quite wisely, it is based on the premise that if you start investing a bit each year in infrastructure today, you will avoid the need to make a staggering investment in the future. From this perspective, this bill is important because it places on the congressional agenda the issue of maximizing the cost efficiency of Federal investments in the infrastructure of science, engineering, and technology.

But equally important as maximizing cost efficiency is the demoralizing impact of inadequate facilities on the university research community. A large part of our membership, including myself, consists of bench scientists and engineers in universities. For many of our individual members, inadequate facilities means that good research just cannot be done. For the people who entered science and engineering because they were turned on by the discovery of knowledge, that's a good definition of frustration.

Inadequate and outdated facilities means that graduate students are crammed into small offices in isolated campus nooks, and they must wait their turn before they can conduct dissertation-related research on scarce equipment. That's another good definition of frustration.

Undergraduate students observe this level of frustration and decide to pursue apparently less frustrating careers. Student enrollment in the sciences has been dropping on my campus.

H.R. 2823 can also help relieve the dramatic impacts on university research that will result from new laboratory standards. For example, there is increasing public and legislative demand for stricter guidelines on regulations concerning the care, treatment, and housing of laboratory animals.

At a conference that NCST held last year on the uses of animals in research, we learned that the National Institutes of Health will soon require that all laboratories wanting NIH funding must comply with their new standards. Life scientists certainly want new and more modern facilities. However, the NIH officials pointed out that their agency cannot be expected to pay the costs of the modernization that will be required for compliance, and they estimated that laboratory compliance would cost at least $500 million nationwide.

As scientists we find ourselves trying to solve the conundrum you have addressed to H.R. 2823. With so many urgent needs and only a limited amount of support, how should research dollars be allocated? We see no easy answers. Clearly, though, as our research facilities continue to age, we eventually will be forced to upgrade physical plants.

We applaud you for proposing a plan to upgrade these outmoded research facilities systematically so that scientists in the behavioral, social, and physical sciences may continue their important work.

Before closing, let me say a few words about two aspects of the bill the committee may wish to address. The first aspect is, where will the money come from? The likelihood of increased appropriations if this bill is enacted is apparently small. We believe that any new funding should be defined in such a way as to ensure that it does not merely represent a reprogramming of agency funds already going to the replacement or modernization of laboratories and other research facilities. Nor should appropriations be taken from programs committed to basic research.

The second aspect concerns what the money can be used for. The replacement or modernization of laboratories and other research facilities called for in this bill will require both physical plants and equipment. We commonly consider both aspects under the term "facilities." The newest building, without suitable equipment, makes a poor laboratory.

We believe the language of the bill should clarify that funds can be used for both of these, including equipment which may not fall within the definition of "fixed equipment and major research equipment." The key question in determining what should be funded is, "What is required to modernize an existing lab or to install a new one?" As the cost of new equipment and facilities increase, so does the cost of maintaining this equipment. Smaller colleges and universities find that the maintenance of that equipment or facility becomes an ever-increasing burden and a demand on their fragile resources.

As we understand it, H.R. 2823 requires that institutions provide at least 50 percent matching funds to obtain Federal grants for replacement or modernization of specific research facilities.

We would like to suggest that universities and research institutions may elect to make their contribution, in part, by earmarking funds to cover the costs of maintenance and repair of the facilities and equipment specifically obtained under this legislation. This formula has the added benefit of allowing colleges and universities to compete more effectively—the smaller colleges and universities to compete more effectively—by permitting them to make some of their matching commitments over several years instead of in 1 fiscal year.

I note that in the recently released "Opportunities in Chemistry," or what is referred to as the "Pimentel Report," one of the recommendations repeated over and over was that funding of equipment include funds for maintaining and operating that equipment for a 5-year period.

We wholeheartedly support this bill, and we stand ready to work for enactment of legislation in this area.

Thank you.

[The prepared statement of Mr. Garin follows:]

TESTIMONY OF
THE NATIONAL COALITION FOR SCIENCE AND TECHNOLOGY
ON
H.R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985
BEFORE THE
HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OCTOBER 24, 1985

TESTIMONY DELIVERED BY: DR. DAVID GARIN, TREASURER, N.C.S.T.; AND ASSOCIATE PROFESSOR OF CHEMISTRY, UNIVERSITY OF MISSOURI-ST. LOUIS

MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE, MY NAME IS DAVID GARIN. I AM THE TREASURER OF THE NATIONAL COALITION FOR SCIENCE AND TECHNOLOGY. I AM ALSO ASSOCIATE PROFESSOR OF CHEMISTRY AT THE UNIVERSITY OF MISSOURI-ST. LOUIS. I APPRECIATE THE OPPORTUNITY TO PRESENT TESTIMONY TODAY. THE LEGISLATION WHICH YOU HAVE BEFORE YOU IS LONG OVERDUE. ADEQUATE FUNDING FOR THE INFRASTRUCTURE ON WHICH GOOD SCIENCE AND ENGINEERING RELIES IS THE KIND OF ISSUE WHICH IT SEEMS CONGRESS IS ALWAYS GOING TO ADDRESS "NEXT YEAR". SO NEXT YEAR FADES INTO NEXT YEAR AND THE NEXT THING YOU KNOW IT'S THE NEXT DECADE. IMPORTANT RESEARCH DOES NOT GET DONE BECAUSE OF A LACK OF SPACE AND EQUIPMENT.

QUITE SIMPLY, AT SOME POINT THE USEFUL LIFE OF ANY BUILDING OR PIECE OF EQUIPMENT IS FOR ALL PRACTICAL PURPOSES OVER. IT IS NO DIFFERENT THAN THE SITUATION WITH THE OLD "JUNKERS" MANY OF US DROVE DURING OUR STUDENT DAYS. THE CARS PROVIDED TRANSPORTATION, BUT YOU SPENT A LOT OF TIME FIXING THEM, THEY WASTED A LOT OF GAS AND OIL, THEY REALLY WERE NOT VERY SAFE, AND EVERYBODY SOLD THEM OR SCRAPPED THEM WHEN THEY GOT THAT FIRST "GOOD JOB".

AS WAS THE CASE WITH THOSE OLD CARS, AT SOME POINT IN TIME WE EITHER HAVE TO FIX LABORATORY AND RESEARCH FACILITIES OR BUY NEW ONES. THE PRECISE POINT IN TIME WHEN THIS IS DONE IS ARBITRARY, BUT FEW WILL DENY IT MUST BE DONE. THE LEGISLATION BEFORE YOU, QUITE WISELY, IS BASED ON THE PREMISE THAT IF YOU START INVESTING A BIT EACH YEAR IN INFRASTRUCTURE TODAY YOU WILL AVOID THE NEED TO MAKE A STAGGERING INVESTMENT IN THE FUTURE. FROM THIS PERSPECTIVE, THIS BILL IS IMPORTANT BECAUSE IT PLACES ON THE CONGRESSIONAL AGENDA THE ISSUE

OF MAXIMIZING THE COST-EFFICIENCY OF FEDERAL INVESTMENTS IN THE INFRASTRUCTURE OF SCIENCE, ENGINEERING, AND TECHNOLOGY.

THE DEMORALIZING IMPACT OF INADEQUATE FACILITIES ON THE UNIVERSITY RESEARCH COMMUNITY IS AS IMPORTANT AS THE MORE ABSTRACT ISSUE OF MAXIMIZING COST-EFFICIENCY DURING INVESTMENT. FOR MOST RESEARCHERS, THIS ISSUE IS ALSO FAR MORE REAL IN OUR EVERYDAY LIVES.

A LARGE PART OF OUR MEMBERSHIP, INCLUDING MYSELF, CONSISTS OF BENCH SCIENTISTS AND ENGINEERS IN UNIVERSITIES. FOR MANY OF OUR INDIVIDUAL MEMBERS, INADEQUATE FACILITIES MEANS THAT GOOD RESEARCH JUST CANNOT BE DONE. FOR PEOPLE WHO ENTERED SCIENCE AND ENGINEERING BECAUSE THEY WERE "TURNED ON" BY THE DISCOVERY OF NEW KNOWLEDGE, THAT'S A GOOD DEFINITION OF FRUSTRATION. INADEQUATE AND OUTDATED FACILITIES MEANS THAT GRADUATE STUDENTS ARE CRAMMED INTO SMALL OFFICES IN ISOLATED CAMPUS NOOKS AND THEY MUST WAIT THEIR TURN BEFORE THEY CAN CONDUCT DISSERTATION RELATED RESEARCH ON SCARCE EQUIPMENT. THAT'S ANOTHER GOOD DEFINITION OF FRUSTRATION. UNDERGRADUATE STUDENTS OBSERVE THIS LEVEL OF FRUSTRATION AND DECIDE TO PURSUE APPARENTLY LESS FRUSTRATING CAREERS.

H.R. 2823 CAN ALSO HELP RELIEVE THE DRAMATIC IMPACT ON UNIVERSITY RESEARCH THAT WILL RESULT FROM NEW LABORATORY STANDARDS. FOR EXAMPLE, THERE IS INCREASING PUBLIC AND LEGISLATIVE DEMAND FOR STRICTER GUIDELINES OR REGULATIONS CONCERNING THE CARE, TREATMENT AND HOUSING OF LABORATORY ANIMALS. AT A CONFERENCE THAT N.C.S.T. HELD LAST YEAR ON "THE USES OF ANIMALS IN RESEARCH", WE LEARNED THAT THE N.I.H. WILL

SOON REQUIRE THAT ALL LABORATORIES WANTING N.I.H. FUNDING, MUST COMPLY WITH THEIR NEW STANDARDS.

FEW LIFE SCIENTISTS WILL WANT TO ARGUE THAT IMPROVED ANIMAL CARE IS NOT DESIRABLE AND ALMOST ANYONE WHO WORKS WITH ANIMALS IN OUTMODED AND INADEQUATE CIRCUMSTANCES WILL WANT NEW AND MORE MODERN FACILITIES. HOWEVER, THE N.I.H. OFFICIALS ALSO POINTED OUT THAT THEIR AGENCY CANNOT BE EXPECTED TO PAY THE COSTS OF THE MODERNIZATION THAT WILL BE REQUIRED FOR COMPLIANCE. THEY ESTIMATED THAT LABORATORY COMPLIANCE WITH THE NEW REGULATIONS WOULD COST AT LEAST 500 MILLION DOLLARS NATIONWIDE. AND THIS IS JUST TO IMPROVE ANIMAL CARE FACILITIES IN OUR UNIVERSITIES AND COLLEGES. YOUR PROPOSED LEGISLATION CAN GO A LONG WAY TO HELP PROVIDE THOSE UPGRADED FACILITIES.

UPGRADING PHYSICAL FACILITIES IS ALSO IMPORTANT TO THE FUTURE GROWTH OF THE BEHAVIORAL AND SOCIAL SCIENCES. MANY OF THE MOST PRESSING AND COSTLY PROBLEMS FACED BY OUR SOCIETY RELATE TO HUMAN BEHAVIOR. AS ONLY ONE EXAMPLE, THE SURGEON GENERAL OF THE UNITED STATES, IN HIS REPORT HEALTHY PEOPLE, CONCLUDED THAT SEVEN OF THE 10 LEADING CAUSES OF DEATH IN THE UNITED STATES, ACCOUNTING FOR FULLY 50 PERCENT OF ALL DEATHS EACH YEAR, ARE IN LARGE PART BEHAVIORALLY DETERMINED AND CAN BE SIGNIFICANTLY REDUCED BY CHANGING PEOPLE'S BEHAVIOR. RESEARCH IS ESSENTIAL TO EXPANDING OUR KNOWLEDGE ON HEALTH AND BEHAVIOR. OTHER IMPORTANT CONTRIBUTIONS BEING MADE BY THE BEHAVIORAL AND SOCIAL SCIENCES ARE IN THE AREAS OF PRODUCTIVITY, DELINQUENCY, MENTAL DISORDERS, DRUG ABUSE, AND FAILURES TO LEARN AND ACHIEVE. OBVIOUSLY THE FINDINGS OF BEHAVIORAL AND SOCIAL SCIENTISTS CAN MAKE A SIGNIFICANT CONTRIBUTION TO THIS COUNTRY'S WELL-BEING AND ECONOMY.

WHILE SOME OF THE PROBLEMS RELATED TO HUMAN BEHAVIOR AND THE REALIZATION OF HUMAN POTENTIAL CAN BE STUDIED IN NATURAL SURROUNDINGS, MANY REQUIRE A SYSTEMATIC PROGRAM OF LABORATORY BASED RESEARCH. RECENT ADVANCES IN COMPUTER TECHNOLOGY AND IN STRATEGIES FOR MAKING AND ANALYZING OBSERVATIONS HAVE MADE SOPHISTICATED EQUIPMENT NECESSARY FOR USE IN BEHAVIORAL AND SOCIAL SCIENCE RESEARCH. THE USE OF SUCH EQUIPMENT IN ADEQUATE LABORATORY FACILITIES HOLDS SIGNIFICANT PROMISE FOR MAKING IMPORTANT ADVANCES IN BOTH THE BEHAVIORAL AND SOCIAL SCIENCES.

AS SCIENTISTS WE FIND OURSELVES TRYING TO SOLVE THE CONUNDRUM YOU HAVE ADDRESSED THROUGH H.R. 2823. WITH SO MANY URGENT NEEDS AND ONLY A LIMITED AMOUNT OF SUPPORT HOW SHOULD RESEARCH DOLLARS BE ALLOCATED? WE SEE NO EASY ANSWERS. CLEARLY, THOUGH, AS OUR RESEARCH FACILITIES CONTINUE TO AGE WE EVENTUALLY WILL BE FORCED TO UPGRADE PHYSICAL PLANT. WE APPLAUD YOU, MR. CHAIRMAN, FOR PROPOSING A PLAN TO UPGRADE THESE OUTMODED RESEARCH FACILITIES SYSTEMATICALLY SO THAT SCIENTISTS IN THE BEHAVIORAL, SOCIAL AND PHYSICAL SCIENCES MAY CONTINUE THEIR IMPORTANT WORK.

LOOKING AHEAD, WE SEE ADDITIONAL CHALLENGES THAT WILL HAVE TO BE ADDRESSED. THERE IS, FOR EXAMPLE, AN IMPORTANT NEED FOR RESEARCH INSTRUMENTATION THAT WE WILL BE FORCED TO CONFRONT IN THE NEAR FUTURE. IN RECENT TESTIMONY TO THIS COMMITTEE'S SCIENCE POLICY TASK FORCE, DR. R. DUNCAN LUCE POINTED TIME AND AGAIN TO THE IMPORTANT ROLE THAT SUPERCOMPUTERS AND OTHER ADVANCED COMPUTATIONAL DEVICES WILL BE PLAYING IN FERTILE RESEARCH AREAS SUCH AS COGNITIVE SCIENCE, LINGUISTICS, PERCEPTION, ECONOMICS, PSYCHOBIOLOGY AND HEALTH AND BEHAVIOR RESEARCH OVER THE NEXT TEN YEARS. WHILE SOME MAY BE SURPRISED THAT BEHAVIORAL

AND SOCIAL SCIENTISTS REQUIRE SUCH POWERFUL COMPUTERS, THERE IS LITTLE DIFFERENCE IN COMPUTATIONAL COMPLEXITY BETWEEN ECONOMIC FORECASTING AND WEATHER FORECASTING OR BETWEEN UNDERSTANDING HOW WE ACTUALLY ARE ABLE TO PERCEIVE A SUNSET AND SIMULATING THE FLIGHT OF AN AIRCRAFT.

NOW, IT'S TRUE THAT FEW OF OUR MEMBERS ARE GOING TO ABANDON THEIR CAREERS BECAUSE LABORATORY SPACE IS NOT AVAILABLE OR EQUIPMENT AND FACILITIES ARE ANTIQUATED. NOR WILL RESEARCH GRIND COMPLETELY TO A HALT. BUT WHAT ABOUT THE FUTURE?

OF COURSE, INVESTING IN THE INFRASTRUCTURE OF SCIENCE, ENGINEERING, AND TECHNOLOGY COSTS MONEY. SOME OF THAT MONEY CAN BE RAISED BY THE MEMBERS OF OUR COMMUNITY. BUT WE WOULD REMIND YOU OF WHAT PLATO NOTED IN THE REPUBLIC: A PERSON ENGAGED IN THE MONEYMAKER'S ART IS LIKELY TO BE TOO BUSY TO BE VERY GOOD AT THE PURSUIT OF TRUTH. IF THE CIVIL SERVANTS IN THE AGENCIES, THE REPRESENTATIVES AND SENATORS IN CONGRESS, THE PRESIDENT, AND THE AMERICAN PEOPLE WANT US TO KEEP FOCUSING OUR ATTENTIONS ON DOING RESEARCH ON TOPICS FROM CANCER TO CERAMICS TO COOPERATIVE LABOR-MANAGEMENT RELATIONS, WE NEED SOME HELP IN RAISING ENOUGH MONEY TO MAINTAIN THE FACILITIES THIS RESEARCH DEMANDS. THE EXISTENCE OF FEDERAL MATCHING FUNDS IS A MAJOR HELP IN RAISING FUNDS FROM STATE AND LOCAL GOVERNMENTS, INDUSTRY, AND FOUNDATIONS.

WE NEED HELP AND H.R. 2823 COULD PROVIDE IT. FOR THAT REASON WE WHOLEHEARTEDLY ENDORSE THIS BILL. THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT WILL NOT SOLVE ALL OF OUR FACILITIES PROBLEMS, BUT

IT WILL PROVIDE MEANINGFUL FUNDING IN A MANNER WHICH WILL MAKE IT EASIER, ALBEIT IMPERATIVE, TO TAP NON-FEDERAL DOLLARS.

BEFORE CLOSING, LET ME SAY A FEW WORDS ABOUT TWO ASPECTS OF THE BILL THE COMMITTEE MAY WISH TO ADDRESS.

THE FIRST ASPECT IS WHERE WILL THE MONEY COME FROM. WE SENT OUR STAFF AROUND TO DISCUSS THE BILL WITH STAFF FOR THE HOUSE AND SENATE APPROPRIATIONS COMMITTEES. THEY ASKED ABOUT THE LIKELIHOOD OF INCREASED APPROPRIATIONS IF THIS BILL WAS ENACTED. I AM SURE YOU CAN GUESS THE REACTION OUR STAFF GOT.

PERHAPS WE SHOULD SHRUG OFF SUCH REACTIONS. AFTER ALL, THE WHOLE FACILITIES ISSUE HAS BEEN A SOURCE OF FRUSTRATION FOR SO LONG, EVEN AN AUTHORIZATION WHICH WAS NOT FUNDED WOULD PROBABLY BE BETTER THAN NO AUTHORIZATION AT ALL. IT RAISES THE HOPE THAT SOMEDAY SOMEBODY MIGHT JUST PUT SOME MONEY IN THE PROGRAMS ESTABLISHED BY THIS BILL.

ONE CAUTION, WE BELIEVE THAT ANY NEW FUNDING SHOULD BE DEFINED IN SUCH A WAY AS TO INSURE THAT IT DOES NOT MERELY REPRESENT A REPROGRAMMING OF AGENCY FUNDS ALREADY GOING FOR THE REPLACEMENT OR MODERNIZATION OF LABORATORIES AND OTHER RESEARCH FACILITIES. NOR SHOULD APPROPRIATIONS BE TAKEN FROM PROGRAMS COMMITTED TO BASIC RESEARCH.

THE SECOND ASPECT CONCERNS WHAT THE MONEY CAN BE USED FOR. IN OUR TESTIMONY WE HAVE HIGHLIGHTED THE NEEDS EXISTING FOR BOTH PHYSICAL PLANT AND EQUIPMENT. THE REPLACEMENT OR MODERNIZATION OF LABORATORIES AND OTHER RESEARCH FACILITIES CALLED FOR IN THIS BILL WILL REQUIRE

BOTH PHYSICAL PLANT AND EQUIPMENT. WE COMMONLY CONSIDER BOTH ASPECTS UNDER THE TERM FACILITIES AS THE NEWEST BUILDING WITHOUT SUITABLE EQUIPMENT MAKES A POOR LABORATORY. YET THE LEGISLATION BEFORE YOU IS WIDELY SEEN PRIMARILY AS A VEHICLE FOR FUNDING BUILDINGS. WE BELIEVE THE LANGUAGE OF THE BILL SHOULD CLARIFY THAT FUNDS CAN BE USED FOR BOTH OF THESE, INCLUDING EQUIPMENT WHICH MAY NOT FALL WITHIN THE DEFINITION OF "FIXED EQUIPMENT AND MAJOR RESEARCH EQUIPMENT". THE KEY QUESTION IN DETERMINING WHAT SHOULD BE FUNDED IS WHAT IS REQUIRED TO MODERNIZE AN EXISTING LAB OR TO INSTALL A NEW ONE.

AS THE COST OF NEW EQUIPMENT AND FACILITIES INCREASE, SO DOES THE COST OF MAINTAINING THIS EQUIPMENT. SMALLER COLLEGES AND UNIVERSITIES FIND THAT THE MAINTAINENCE OF THAT EQUIPMENT OR FACILITY BECOMES AN EVER INCREASING BURDEN AND DEMAND ON THEIR FRAGILE RESOURCES. SO, WHEN INDIVIDUAL RESEARCHERS REQUEST FUNDS FOR NORMAL REPAIR AND UPKEEP OF THEIR EQUIPMENT, THEIR REQUESTS ARE DEFERRED OR DENIED WITH THE EXCUSE THAT "CONTINGENCY FUNDS ARE NOT AVAILABLE IN THIS YEAR'S BUDGET". FOR THOSE INVESTIGATORS STRUGGLING TO OBTAIN NEW RESEARCH GRANTS, THEIR INABILITY TO SERVICE EQUIPMENT AND FACILITIES LEADS TO EVEN MORE DETERIORATION AND BECOMES YET ANOTHER FRUSTRATION THAT DETRACTS FROM THEIR PRODUCTIVITY.

AS WE UNDERSTAND IT, H.R. 2823 REQUIRES THAT INSTITUTIONS PROVIDE AT LEAST 50% MATCHING FUNDS TO OBTAIN FEDERAL GRANTS FOR REPLACEMENT OR MODERNIZATION OF SPECIFIC RESEARCH FACILITIES. WE WOULD LIKE TO SUGGEST THAT UNIVERSITIES AND RESEARCH INSTITUTIONS MAY ELECT TO MAKE THEIR CONTRIBUTION, IN PART, BY EARMARKING FUNDS TO COVER THE

COSTS OF MAINTAINANCE AND REPAIR OF THE FACILITIES AND EQUIPMENT SPECIFICALLY OBTAINED UNDER THIS LEGISLATION. THIS FORMULA HAS THE ADDED BENEFIT OF ALLOWING SMALLER COLLEGES AND UNIVERSITIES TO COMPETE MORE EFFECTIVELY WITH THEIR BETTER ENDOWED COUNTERPARTS IN OBTAINING MODERN RESEARCH RESOURCES. THIS COULD BE ACCOMPLISHED BY PERMITTING THE INSTITUTIONS TO MAKE SOME OF THEIR MATCHING COMMITMENT OVER SEVERAL YEARS INSTEAD OF IN ONE FISCAL YEAR. IN FACT, ONE OF THE RECOMMENDATIONS IN THE RECENTLY RELEASED REPORT, "OPPORTUNITIES IN CHEMISTRY", OR THE PIMENTEL REPORT, IS THAT THE FUNDING OF EQUIPMENT INCLUDE FUNDS FOR MAINTAINING AND OPERATING THAT EQUIPMENT FOR A FIVE-YEAR PERIOD.

TO CONCLUDE, THE LEGISLATION YOU HAVE BEFORE YOU ADDRESSES A REAL AND IMPORTANT PROBLEM. TOO OFTEN VITAL INFRASTRUCTURAL INVESTMENTS ARE PUT OFF. BY EARMARKING FUNDS FOR LABORATORY AND RESEARCH FACILITIES MODERNIZATION AND REPLACEMENT, THIS LEGISLATION WOULD END THE CURRENT SITUATION OF NEGLECT. FOR THIS REASON WE WHOLEHEARTEDLY SUPPORT THIS BILL AND STAND READY TO WORK FOR ENACTMENT OF LEGISLATION IN THIS AREA WITH THE COMMITTEE AS WELL AS ALL OTHERS INTERESTED IN IMPROVING THE INFRASTRUCTURE OF SCIENCE, ENGINEERING, AND TECHNOLOGY.

N.C.S.T. is a non-partisan, non-profit coalition of individuals and professional associations and R & D intensive corporations active in science, engineering, and technology. N.C.S.T. seeks to secure the infrastructure needed to sustain long-term U.S. excellence and leadership in science, engineering and technology.

This testimony was developed with the assistance of several members of the N.C.S.T. executive committee. As such, it may not represent the views of specific members or advisors.

Mr. **Walgren**. Thank you all very much.

We have another rollcall on the floor, so I would like to go immediately to Mr. Valentine if he has any questions he would like to raise and discussion to focus on.

Mr. **Valentine**. Thank you very much, Mr. Chairman. I would like to ask Dr. Goodwin a couple of questions.

Doctor, would you describe for us the relationship that Duke University has with the other universities that make up the Triangle Universities Computation Center, and tell something about that institution?

Mr. **Goodwin**. Indeed. Well, we've had the good fortune, Mr. Congressman, to find that cooperation among the universities in the Triangle area was a very effective way of coping with some of the problems that have been discussed today, the problems of maintaining equipment and facilities in big science.

Over the last 20 years or so we have engaged in many cooperative ventures. One of the first of these was the Triangle Universities Computation Center, which has a facility centered between the three universities in the middle of Research Triangle Park. This serves the three universities as well as other facilities in the park on a time-sharing basis.

In addition to TUC, as we call it, we have a variety of other facilities which are shared, most of them based on Federal construction grants at an early period. I have mentioned Tunnel, the Phytotron, which is a biological facility. I have mentioned the research vessel. All of these run jointly by the Triangle Universities. The Microelectronic Center of North Carolina is another example which involves the State and corporate sponsors as well as the Federal Government, the Research Triangle Institute.

And we have an organization called the Triangle Universities Center for Advanced Studies, Inc., which is designed to foster this type of cooperation.

Mr. **Valentine**. What are some of the research projects which are currently underway at Duke which, in your opinion, would be facilitated by the passage of this legislation?

Mr. **Goodwin**. Well, I know the time is short, and perhaps I should just give you one which is, I think, especially interesting. We have underway in our Phytotron at the moment, this biological facility, a study of the effect of CO_2—carbon dioxide—increase in the air on biological organisms. As I indicated in my prepared testimony, this research is constrained by the size of the chambers which exist in this Phytotron. If we had additional construction money, we would like to enlarge that facility, which again serves all of these Triangle Universities, to make possible the experimentation with larger botanical—trees rather than small plants at the moment.

I could give you examples in physics and chemistry. Virtually all of our sciences could be very much affected by this legislation.

Mr. **Valentine**. Thank you, Doctor.

Mr. Chairman, I thank you for giving me this opportunity. I want to say to the other members of the panel that my interest is in Dr. Goodwin, but it's in all of you. You know, he's home folks, and I do want to tell you that I think you do great work, and I appreciate the contribution which you make. I thank you for coming here. We listen to you, this member does, and this chairman.

Thank you all so much.

Mr. **Walgren**. Thank you, Mr. Valentine.

Let me ask quickly, and then I will have to go over to the floor as well. Is there agreement that we are—well, obviously at some point in the running down of research facilities there would be very broad agreement that even if it took away money from current research, the best use, the best thing to do with the available money would be to build up a deficient aspect of this whole area, being facilities at that point. We still get in the testimony that, "Doggone it, this might take away money from current research, and we shouldn't do that." Is there agreement that we have reached the point where that's what we should do, even if it did that?

I mean, obviously, if we were about to close all the laboratories, somebody would say, "Well, spend the money this year to keep them open as opposed to current research or something like that."

Have we reached that point where, from your perspectives, the modernization of the facility has such priority that that is No. 1?

Mr. **Speser**. I will take a stab at it. I think that from our perspective we would say that there is an agreement that something needs to be done. I would have to echo my colleague over here's comment that if we were to start looking at tradeoffs today to say we're going to take a specific percentage now right off the top, that I don't think you would find any agreement on.

Mr. **Walgren**. What about 5 percent?

Mr. **Speser**. I think that the community has not examined it closely enough at this point to say abstractly what percent there should be. There is no question that we are approaching a problem. I don't think we are at the point now where we have a meeting of the——

Mr. **Walgren**. There would be support for some percentage, in the abstract?

Mr. **Speser**. In the abstract, of course. I mean, you could get it down at some point where it'd be point-something-something-something-something, and everybody would say, "Sure, that's de minimis, and there's no problem there." I think the more important thing is——

Mr. **Walgren**. What about something more than a de minimis percent?

Mr. **Speser**. Well, I think personally, speaking only personally, I think something more than a de minimis would be appropriate from the standpoint that we have a tendency in this country to put our infrastructural investments off on the assumption that we will deal with them next year and next year and next year, and the time has come, as we have seen in area after area, that we can no longer operate that way. And I think that's the important message in this piece of legislation.

Dr. **Sherman**. May I suggest, Mr. Walgren——

Mr. **Walgren**. Certainly.

Dr. **Sherman** [continuing]. That rather than establishing a fixed percentage, that it would be preferable to provide the other route that would indeed permit year-to-year adjustments through a permanent authority or a time and dollar ceiling authority. There, then, the question of the relationship between dollars direct cost for research and direct cost for facilities and the infrastructure could be more clearly and more promptly identified and modifications made on a year-to-year basis as to what the consensus of the community may be at that time.

I would agree that there is a general sense of disease within the community at the moment of anything that would suggest diversion of funds for research.

Mr. **Walgren**. Yes, but we would think that we're in a time supposedly when these direcctors of research for these Federal agencies are going to have less and less money to deal with, and therefore there will be more and more pressure on them to conduct their operating research as opposed to make any longer term investment.

Do you think we're in a position to simply say, "Well, we want you to do it. There's a ceiling you can hit. Anywhere from zero to full allotment under the bill in that"? Do you think you would get the necessary drive?

Mr. **Sherman**. I think it will come. My own personal sense from talking to both administrators and faculty members at the moment is that the nature of the change in the Nation's economic situation and the prospects for support for research, whether you're talking direct or infrastructure support, has not yet occurred. The community is behind the facts, I think, in the temporal sense.

It is my sense that we're too early at that issue in order to arrive at a conclusion for a fixed amount. A range or a separate authority would seem to be preferable at this time for that degree of flexibility.

Mr. **Walgren**. Any other reactions, Dr. Phillips? Do you have a reaction to that?

Mr. **Phillips**. I would just, I guess, agree with the sense of your question from our experience, in that there is no agreement. The input that we have received and that was expressed at our conference ranged from, "Yes, I know there's going to be a tradeoff, but that's what we need now. The times are such that if we don't make those hard choices, 20 years from now we'll be doing bad science in bad facilities," to the other extreme, "Well, if this means taking any money out of research programs, I am not for it."

And at those two extremes, I think it's the administrators, the people who may be more current in a temporal sense, as Dr. Sherman said, who see the broader picture, who are more inclined to say that we've got to make the hard choice and they're willing to make the tradeoff with the individual working scientists and engineers on the other side who see the context of their own research program and see funds being cut, they're losing a research assistant or a graduate student, saying, "I just can't take a cut in my research program budget."

I don't think there is consensus for that tradeoff.

Mr. **Speser**. I would just add, sir, that I spoke yesterday with several of our corporate members about this piece of legislation, and there is some concern there also—while they recognize the need as well—that after being asked to participate in engineering research centers, Presidential Young Investigators, university-industry cooperative research, university-industry cooperative research projects, that this is another match that's coming down the line. So the trade-offs that we're seeing on the academic side exist in the corporate sector as well in terms of what percentage of what fund should go to what particular kind of function.

So from that standpoint, again, it's hard to say if you took a 10 percent you could outrun the matchability, in a sense.

Mr. **Walgren**. OK. Well, I am sorry we're operating under some time constraints, but let me thank you all very much for being a resource to our committee.

Mr. **Speser**. Thank you for the opportunity.

Mr. **Walgren**. I have got to respond to those bells. So let's take a 10-minute recess, and we will go on to the second panel at that point.

[Recess.]

Mr. **Valentine** [presiding]. The subcommittee will come to order.

I apologize for the chairman's temporary absence. The chairman, of course, is interested in the legislation on the floor. I understand that that has been resolved in a manner satisfactory with him, so he will be back to his duties perhaps before we get very far.

The next panel consists of Dr. Barry Cooperman, Dr. Dan Zaffarano, Dr. James DeShaw, Dr. Thomas D. Nicholson, and Dr. Paul Cumming.

We will hear from your gentlemen in such order as you deem appropriate. I don't know who's in charge.

Dr. Cooperman, you are nominated.

STATEMENT OF BARRY COOPERMAN, VICE PROVOST AND PROFESSOR OF CHEMISTRY, UNIVERSITY OF PENNSYLVANIA; DAN ZAFFARANO, VICE PRESIDENT FOR RESEARCH, IOWA STATE UNIVERSITY; JAMES DeSHAW, DEPARTMENT OF LIFE SCIENCES, SAM HOUSTON STATE UNIVERSITY; AND PAUL CUMMING, DIRECTOR, MARKET RSEARCH AND SUPPORT, AMERICAN RED CROSS

Mr. **Cooperman**. Thank you, Mr. Chairman.

I am Barry Cooperman, professor of chemistry and vice provost for research at the University of Pennsylvania. I appear here today on behalf of the American Association of University Professors, the Nation's largest and oldest professional association of college and university faculty members.

The AAUP endorses the goals of H.R. 2823. Since its founding in 1915 the AAUP has encouraged institutional and governmental assistance to faculty engaged in research. It has supported public and private efforts to expand research facilities available to faculty. The AAUP has defended the academic freedom of faculty and helped to create strong institutional governance. It has established high ethical standards for the academic profession and worked jointly with other higher education associations in encouraging the type of academic environments that foster quality teaching and research.

I am pleased to testify before you on the research facilities needs of our Nation's universities and colleges. I speak from the perspective of a concerned physical scientist and university officer responsible for research. The basis of my concern is the lack of renewal and substantial deterioration of our academic research facilities. This is true for virtually every scientific discipline represented in the Academy.

As you know, the development of new technologies has historically been founded in basic research emanating from our colleges and universities. The Federal Government has a considerable stake in these efforts for which it now provides the lion's share.

However, during the last two decades, Federal support for basic research facilities has declined dramatically. As a result, there is now a massive and largely unmet need for the modernization and rehabilitation of existing facilities and for the construction of new facilities.

The existing research base often cannot accommodate contemporary research requirements. Advances in information processing, new research technologies, and sophisticated instrumentation, are stressing the capabilities of current facilities even as they drive demand for the creation of new space.

It is a safe generalization that today the shortage of quality laboratory facilities imposes a major constraint on the rate of scientific progress on our Nation's campuses. Construction, renovation, and rehabilitation of such facilities are critical if we are to sustain growth in our Federal and technical capabilities.

I would like now to consider with you the potential impact of H.R. 2823 on the research programs of the University of Pennsylvania.

Penn is ranked among the 12 largest research universities in the Nation. In fiscal year 1985 Penn had a sponsored research budget of $125 million. Some $102 million was derived from the Federal Government, and the vast majority of this total was obtained through the process of competitive peer review.

For the purposes of this discussion, I will divide our capital needs into three categories and illustrate each with specific examples.

The first is in the area of new fields of research. We are living in an era of rapid progress in science and technology, a time in which we have experienced rapid growth in several fields of inquiry. The enthusiasm and intellectual dynamism underlying such movements are very positive for the university, but create intense demands for new facilities and state-of-the-art technology that we often have difficulty meeting.

One such area is in computer science. The graduate enrollment in this department has more than doubled in the last few years, and it is now among the largest graduate departments in the university. Its research support has also increased dramatically, from $1.3 million in 1981 to $4.6 million in 1985.

To accommodate this growth, our School of Engineering proposed the construction of a new wing for computer science at a cost of about $7 million. The plan is sound, responds to a real need, and has the endorsement of the board of overseers of the school. However, we have had to proceed at a snail's pace in implementing the plan because of a lack of resources. At present, some classes are being taught in trailers, and only limited computer laboratory space is available for advanced student training.

Our second area of capital need is in the maintenance of the quality of traditionally excellent research programs. Our recent efforts in two of our science departments, biology and chemistry, well illustrate this need.

Pennsylvania recognized the revolution that was occurring in biology as a whole and in plant science in particular, starting in the late 1970's. To confront the challenge posed by this revolution, the university in 1978 endorsed the plan to revitalize and expand the department of biology. The goals of the plan—some of them already met, others headed toward completion—were to increase the biology faculty, to stimulate interdisciplinary collaboration, and to modernize and expand the department's physical facilities. In the first construction phase of this plan, $6.3 million was spent for a major renovation of existing laboratories in 1982.

Currently, construction is underway of the Seeley G. Mudd Biology Research Laboratory. This new facility will contain more than 14,000 square feet of usable laboratory space at a projected cost of $5.5 million. Its primary purpose will be to provide a modern facility to house our new plant science institute, which is conducting studies on the molecular and developmental biology of plants. Completion will mark the culmination of the renewal effort in biology begun in 1978. As of now, only a modest fraction of the cost of this building has been raised from external sources. The university is engaged in active fundraising to increase this fraction.

Chemistry, too, is a department that has had a vigorous research program over a long period of time. It is now in the midst of a rapid growth in resources and quality. Its research budget has increased from $3 million in fiscal year 1981 to $5.2 million in fiscal year 1985. Much of the recent success of this department can be traced to the construction in 1973 of a modern teaching and research complex. The resources provided by this facility have attracted excellent new faculty and led to increased graduate student enrollment, with a concomitant increase in the need for additional modern laboratory facilities.

The university is committed to meeting this need, not only because of the importance of the department of chemistry within the context of the university's research and educational priorities, but also because of the importance of the chemical and related industries to the local regional economy. There are no fewer than 98 companies falling into this category in Philadelphia and its environs. Local industry has had a close relationship with the department, and we expect this relationship to continue to grow.

We estimate that approximately $20 million will be needed for new and renovated laboratory space in chemistry over the next 5 years, of which about half will be for instructional and half for research needs.

We have raised the first $2 million of this amount and are proceeding piece-meal to implement their plan, but expect that raising the remainder will be a slow and difficult process.

It's important to point out that despite our friendly relations with local industry, we have seen very little interest on their part in contributing to major capital programs.

The third area of need derives from the immense pressure we face in ensuring compliance with the new regulatory initiatives governing animal research, environmental health, and the handling and disposal of radioactive or toxic material. In general, we support these new requirements and the higher standards of care and safety they bring. However, regulation does increase the cost of research, in some cases quite markedly.

A timely case in point is laboratory animal care. The standards for acceptable facilities, care, and protocols for the use of laboratory animals are going through a period of rapid evolution. As you may know, Penn has had a particularly painful time in dealing with this issue over the past year.

As a result, we are in the midst of a major reorganization and restructuring to make certain that we are in full compliance with all Federal regulations and guidelines regarding the use and care of laboratory animals. Part of this effort is devoted toward the renovation of existing facilities and the construction of new facilities.

The costs of projects in this area that we are beginning in fiscal year 1986 will total approximately $18 million. While there is no question that these projects must be carried out, it is equally obvious that making such an effort seriously affects our ability to move forward with our plans for other research laboratory modernization.

In closing, I would like to suggest certain amendments to H.R. 2823 which in my judgment will enhance its ability to revitalize the Nation's academic research programs.

First, I agree on the desirability of awarding funds under this act on a competitive basis. However, I believe that some agencies may choose to develop a formula allocation mechanism. Such a mechanism would be based upon the amount of competitive research funds awarded to grantee institutions. The current draft would make awards solely on the basis of specific proposals submitted by universities and colleges.

The rationale for the suggested change is that, in general, the amount of funds needed for facility modernization will be proportional to the total amount of research funds awarded. Such an approach would have a very favorable impact on the ability of institutions to develop and carry out long-range plans for facility modernization. The additional advantage of reducing the sizable administrative costs of the proposal review process at both the institutional and agency levels is significant, although less crucial.

Second, I support the notion of a 50-percent match of costs. However, I believe that such costs should be defined so as to include fixed equipment and major research instrumentation. The rationale here is to ensure that universities and colleges will be able to equip modern research laboratories with modern research equipment.

Third, I believe the act should state that universities or colleges need verify the receipt of non-Federal public or private funds only upon completion of the construction or modernization of a facility. The success of this legislation depends upon the ability of the colleges and universities to raise the required matching funds. This process is greatly facilitated if it can be carried out during the duration of a project as opposed to being a precondition for a project initiation.

This concludes my prepared remarks. I want to thank the committee for giving me this opportunity to testify, and I would be happy to answer any questions you might have.

[The prepared statement of Mr. Cooperman follows:]

TESTIMONY OF BARRY S. COOPERMAN, PROFESSOR OF CHEMISTRY AND VICE PROVOST FOR RESEARCH, UNIVERSITY OF PENNSYLVANIA, BEFORE THE SCIENCE AND TECHNOLOGY SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY

Mr. Chairman and Members of the Subcommittee: I am Barry S. Cooperman, professor of chemistry and vice provost for research at the University of Pennsylvania. I appear here today on behalf of the American Association of University Professors, the nation's largest and oldest professional association of college and university faculty members.

The American Association of University Professors endorses the goals of H.R. 2823. Since its founding in 1915, the AAUP has encouraged institutional and governmental assistance to faculty engaged in research and has supported public and private efforts to expand research facilities available to faculty. It has defended the academic freedom of faculty, assisted in creating strong institutional governance, including faculty research committees, and has encouraged increased research programs that contribute to the quality of university curricula. The range of its interests has included the establishment of National Research Service Awards to the funding of research university libraries under Title II(C) of the Higher Education Act. More recently, the AAUP has joined with other higher education associations in and effort to resolve internal institutional debates over "indirect costs" and to reaffirm support for the peer review process in the awarding of federal grants for construction of university-based facilities.

I am pleased to testify before you on the research facilities needs of our Nation's universities and colleges. I speak from the perspective of a concerned physical scientist and university officer responsible for research. The basis of my concern is the lack of renewal and substantial deterioration of our academic research facilities. This is true for virtually every scientific discipline represented in the Academy.

As you know, the development of new technologies has historically been founded in basic research emanating from our colleges and universities. The Federal Government has a considerable stake in these efforts, for which it now provides the lion's share of support. However, during the last two decades Federal support for basic research facilities has declined dramatically. As a result there is now a massive and largely unmet need for the modernization and rehabilitation of existing facilities and for the construction of new facilities.

Existing research space often cannot accommodate contemporary research requirements. Advances in information processing, new research technologies, and sophisticated instrumentation are stressing the capabilities of current facilities even as they drive demand for the creation of new space.

It is a safe generalization that today the shortage of quality laboratory facilities imposes a major constraint on the rate of scientific progress on our Nation's campuses. Construction, renovation, and rehabilitation of such facilities are critical if we are to sustain growth in our scientific and technical capabilities.

I'd like now to consider with you the potential impact of H.R. 2823 on the research programs of the University of Pennsylvania. Penn is ranked among the twelve largest research universities in the Nation. In FY'85 Penn had a sponsored research budget of $125 million. Some $102 million was derived from the Federal Government, and the vast majority of this total was obtained through the process of competitive peer-review.

For purposes of discussion, I will divide our capital needs into three categories and illustrate each with a specific example.

The first is in the area of new fields of research. We are living in an era of rapid progress in science and technology, a time in which we have experienced rapid growth in several fields of inquiry. The enthusiasm and intellectual dynamism underlying such movement are very positive for the University, but create intense demands for new facilities and state-of-the-art technology that we often have difficulty meeting.

One such area is in Computer Science. The graduate enrollment in this department has more than doubled in the last few years and it is now among the largest graduate departments in the University. Its research support has also increased dramatically, from $1.3 million in 1981 to $4.6 million in 1985. To accommodate this growth, our School of Engineering proposed the construction of a new wing for Computer Science at a cost of about $7 million. The plan is sound, responds to a real need, and has the endorsement of the Board of Overseers of the School. However, we have had to proceed at a snail's pace in implementing the plan because of a lack of resources. At present some classes are being taught in trailers and only limited computer laboratory space is available for advanced student training.

Our second area of capital need is in the maintenance of the quality of traditionally excellent research programs. Our recent efforts in two of our science departments, biology and chemistry, well illustrate this need.

Pennsylvania recognized the revolution that was occurring in biology as a whole, and in plant science in particular, starting in the late seventies. To confront the challenge posed by this revolution, the University in 1978 endorsed a plan to revitalize and expand the Department of Biology. The goals of the plan, some of them already met, others headed toward completion, were to increase the Biology faculty, to stimulate interdisciplinary collaboration, and to modernize and expand the Department's physical facilities. In the first construction phase of this plan $6.3 million was spent for a major renovation of existing laboratories in 1982. Currently, construction is underway of the Seeley G. Mudd Biology Research Laboratory. This new facility will contain more than 14,000 square feet of usable laboratory space at a projected cost of $5.5 million. Its primary purpose will be to provide a modern facility to house our new Plant Science Institute, which is conducting studies on the molecular and developmental biology of plants. Its completion will mark the culmination of the renewal effort in biology begun in 1978. As of now, only a modest fraction of the cost of this building has been raised from external sources. The University is engaged in an active fundraising campaign to increase this fraction.

Chemistry, too, is a department that has had a vigorous research program over a long period of time. It is now in the midst of a rapid growth in resources and quality. Its research budget has increased from $3.0 million in FY'81 to $5.2 million in FY'85. Much of the recent success of this department can be traced to the construction in 1973 of a modern teaching and research complex. This replaced the old Harrison Laboratory, built in the 1890s. The resources provided by this facility have attracted excellent new faculty, and led to increased graduate student enrollment, with a concommitant increase in the need for additional modern laboratory facilities. The University is committed to meeting this need not only because of the importance of the Department of Chemistry within the context of the University's research and educational priorities, but also because of the importance of the chemical and related industries to the local regional economy. There are no fewer than 98 companies falling into this category in Philadelphia and its environs. Local industry has had a close relationship with the Department and we expect this relationship to continue to grow.

We estimate that approximately $20 million will be needed for new and renovated laboratory space in Chemistry over the next five years, of which about half will be for instructional and half for research needs. We have raised the first $2 million of this amount and are proceeding piecemeal to implement our plan but expect that raising the remainder will be a slow and difficult process. It is important to point out that despite our friendly relations with local industry, we have seen very little interest on their part in contributing to major capital programs.

The third area of need derives from the immense pressure we face in ensuring compliance with the new regulatory initiatives governing animal research, environmental health, and the handling and disposal of radioactive or toxic material. In general we support these new requirements and the higher standards of care and safety they bring. However, regulation does increase the cost of research, in some cases quite markedly. A timely case in point is laboratory animal care. The standards for acceptable facilities, care, and protocols for the use of laboratory animals are going through a period of rapid evolution. As you may know, Penn has had a particularly painful time in dealing with this issue over the past year. As a result, we are in the midst of a major reorganization and restructuring to make certain that we are in full compliance with all Federal regulations and guidelines regarding the use and care of laboratory animals. Part of this effort is devoted toward the renovation of existing facilities and the construction of new facilities. The costs of projects in this area that we are beginning in FY'86 total approximately $18 million. While there is no question that these projects must be carried out, it is equally obvious that making such an effort seriously affects our ability to move forward with our plans for other research laboratory modernization.

In closing, I'd like to suggest certain amendments to H.R. 2833 which in my judgment will enhance its ability to revitalize the Nation's academic research programs. First, I agree on the desirability of awarding funds under this Act on a competitive basis. However, I believe that some agencies may choose to develop a formula allocation mechanism. Such a mechanism would be based upon the amount of competitive research funds awarded to grantee institutions. The current draft would make awards solely on the basis of specific proposals submitted by universities and colleges. The rationale for the suggested change is that, in general, the amount of funds needed for facility modernization will be proportional to the total amount of research funds awarded. Such an approach would have a very favorable impact on the ability of institutions to develop and carry out long-range plans for facility modernization. The additional advantage of reducing the sizable administrative costs of the proposal review process, at both the institutional and agency levels, is significant although less crucial.

Second, I support the notion of a 50 percent match of costs. However, I believe that such costs should be defined so as to include fixed equipment and major research instrumentation. The rationale here is to ensure that universities and colleges will be able equip modern research laboratories with modern research equipment.

Third, I believe the Act should state that universities or colleges need verify the receipt of non-Federal public or private funds only upon completion of the construction or modernization of a facility. The success of this legislation depends upon the ability of the colleges and universities to raise the required matching funds. This process is greatly facilitated if it can be carried out during the duration of a project, as opposed to being a precondition for a project initiation.

This concludes my prepared remarks. I want to thank the Committee for giving me this opportunity to testify. I would be happy to answer any questions you might have.

UNIVERSITY OF PENNSYLVANIA

Curriculum Vitae

BARRY S. COOPERMAN

Home Address:
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358 Chemistry
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University of Pennsylvania
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Date of Birth: December 11, 1941

Place of Birth: Brooklyn, New York

Marital Status: Married 1963-Marlene
Children: Michael Jacques, 1968
Jacqueline Ariane, 1972

Education:

1958-62	B.A.	Columbia College, Magna cum laude, Phi Beta Kappa
1962-68	Ph.D.	Harvard University

Postgraduate Training:

1967-68	Pasteur Institute Paris, France

Faculty Appointments:

1968-1972	Assistant Professor of Chemistry, University of Pennsylvania
1972-1977	Associate Professor of Chemistry, University of Pennsylvania
1977-	Professor of Chemistry, University of Pennsylvania

Administrative Appointments

1968-82	Co-Chairman and then Chairman, Undergraduate Biochemistry Major
1982-	Vice Provost for Research, University of Pennsylvania
1983-	Board of Trustees, Associated Universities Inc.
1984-	Policy Governing Board, Advanced Technology Center for Southeast Pennsylvania
1985-	Board of Managers, Morris Arboretum

Awards and Honors

1962-67	NIH and NSF predoctoral fellow, 1962-1967
1962-67	Graduate Student, Harvard University
1967-68	NATO postdoctoral fellow, Institut Pasteur
1970	Merck Faculty Award
1974-1978	Sloan Foundation Award

Mr. **Walgren** [presiding]. Thank you very much, Dr. Cooperman. We certainly appreciate that contribution.

Let's then turn to Dr. Zaffarano.

Mr. **Zaffarano**. My position is vice president for research and graduate dean at Iowa State University. I am pleased to see that my friend Mr. Cooperman has some of the same concerns as I have. I feel a need to describe our university because we are a little different than his. We are a typical, I would guess, Midwestern university a land-grant university. We are middle range. We have 26,000 total students; about 4,000 graduate students. Our enrollment is still increasing. Our total research expenditures are about half of Dr. Cooperman's. They're about $68 million, but increasing.

We are one of the oldest of the land-grant universities. We have one of the first veterinary colleges in the country, and still probably one of the largest. The National Animal Disease Center for the whole country is located at Ames, IA.

We are the home of a number of things: The first digital computer. I think we argue with the University of Pennsylvania a little bit, but Atanasoff was at Ames, IA, when the first digital computer was invented. The use of statistics in animal breeding was developed at Ames. One of our chemists, Henry Gilman, is the "father" of metallo-organic chemistry. The first uranium for the Chicago West Stands reactor was produced at Ames, IA, in the Ames laboratory. We now produce some of the purest metals anywhere available on the surface of the Earth in the Ames laboratory.

We produce about 200 Ph.D.'s a year and about 500 master's students, and we pump 2,500 B.S. scientists and engineers into the system. They go all over the United States.

So we are a Midwestern university, but we have a very viable research program, and we have produced things which have contributed to the quality of life in this country.

Unfortunately, the State of Iowa at this time is in a state of economic depression. Part of it is due to the lack of diversification of our output in the State, which, as you must know, is agricultural in nature—corn, soybeans, hogs, cows, our principal output.

What is happening now is that our Governor and our legislature, are turning to the university to produce ideas for economic development of the State, for economic diversification. Unfortunately, very little new money is coming our way from the State. But in spite of that, the normal growth of our research program is continuing. Our faculty are working harder to obtain money from foundations, from the Federal Government, from industry.

Now, this bill promises some relief to the problems we have. But I would like to suggest that we need something different than modernization of existing quarters. It is my belief that the number of dollars that are going to be available is insufficient to make a major impact if those dollars are spread over modernization and improvement of all the buildings and facilities that need improvement in research laboratories in universities in this country.

It is my belief that the bill does not focus on the area where we think our university has its greatest problems, and that place is in the development of new programs to meet the economic development needs of our State and also of our country.

Our existing facilities are already well-occupied with current teaching and research demands. We are in a somewhat frustrating circumstance in that we are asked to stimulate technical advance through knowledge production in new research areas where we have the expertise but not the means to do it.

The point is here that major new research demands—which I can elucidate, if you care—which essentially all universities have experienced in the last few years, require more than base infrastructure suppport. They require support for focused research thrusts in new research configurations which go beyond those the university needs to fulfill in its historic mission, which are adequately supported.

It is my opinion that existing funding mechanisms, both State and Federal, are sufficient to address normal infrastructural growth required for traditional teaching and research areas that are the university's responsibility. What is lacking—and this is not generally well recognized—is support for the expansion of university infrastructures which will allow us to establish programs specifically focused on critical national and regional needs.

The universities are repositories for the scientific expertise needed to attack problems of vital interest to the country, but our existing resources are not adequate to take full advantage of that expertise. State funding is, by and large, closely tied to the primary educational mission of the university, and funding from Federal mission agencies is incremental and broadly dispersed and thus cannot address the need for funds for new thrusts.

Consequently, the use of H.R. 2823 financing for the support of base infrastructure activities will probably not help universities to meet the research demands in critical areas. In all likelihood, the result of such funding would be a decrease in State support of research, which would inevitably require redistribution of funds within the university to meet basic needs.

To respond to this problem, I would like to recommend that the committee modify H.R. 2823 as follows: First, the University Research Facilities Revitalization Act should be framed with an expectation that States and institutions will provide the base support to fulfill their historic missions. The programs established by this act should not attempt to revitalize departmental or college facilities simply because the need exists. Every university can show such needs.

What is most needed is support for new research initiatives that address national and regional research problems in a focused way. In this sense, "revitalization" implies initiation of new university research thrusts for which existing programs provide a foundation rooted in the research excellence of the university.

Second, under the act, all facilities revitalization funding should be linked to areas of research which can demonstrate that Federal investment will show an economic return over the next 20 or 30 years—a timeframe consistent with basic research. An analysis of expected benefits should include those of human capital as well as useful knowledge and new technology.

The act should be also a vehicle for interagency cooperation and research infrastructure funding. Scientific and technological problems don't always neatly follow agency statements of mission guidelines. Their solutions should not be impeded by artificial barriers.

In short, I think that the bill should direct the agencies to cooperate in supporting the best proposals that survive close scrutiny.

This bill is welcome and long overdue. We support the bill. We thank you for the opportunity to offer comments.

[The prepared statement of Mr. Zaffarano follows:]

Testimony

by

Daniel J. Zaffarano

Vice President for Research

Iowa State University of Science & Technology

on

The University Research Facilities

Revitalization Act of 1985

Before The

Subcommittee on Science, Research, and Technology

Committee on Science and Technology

U.S. House of Representatives

October 24, 1985

Mr. Chairman, my name is Daniel Zaffarano and I am the Vice President for Research and Dean of the Graduate College at Iowa State University. I have served in that capacity since 1971 and have served on the physics faculty at ISU since 1949. I appreciate the opportunity to testify before this subcommittee regarding HR 2823 and intend to accomplish two goals by my testimony this afternoon.

First, I want to give you a feel for the complexity of the research enterprise at mid-sized research universities such as Iowa State and second, I have some specific recommendations regarding the need to target HR 2823 funding toward new areas of research rather than normal teaching and research activities.

Research activities at Iowa State University take place in eight colleges, 22 research centers and institutes, an Agricultural Experiment Station, and the Ames Laboratory--an on-campus government-owned contractor-operated DOE research laboratory. In FY 1985 $76.6 million were expended in the research enterprise at Iowa State with 35% of the funds for this effort being provided by the state, 45% by the federal government, and 20% by nongovernment sources. The scientific staff of approximately 2,070 FTE's has expertise in: agriculture, materials, energy sciences, biological sciences, veterinary medicine, engineering and basic chemistry/physics. We produce approximately 2,500 scientists and engineers per year (over 500 at the graduate level) of which over 50% leave the state for the national market.

In support of the scientific and technical research effort, ISU has on its main campus many major laboratory buildings (totaling approximately 700,000 square feet). About 85% of the space was built with funding from the State of Iowa, 10% was financed and is owned by the federal government, 2.5%

was jointly financed by the state and federal government and 2.5% was funded by non-governmental sources. In the evolution of this complex, major federal investment occurred in the period between 1950-1962 with the development of the Ames Laboratory facility by DOE predecessor agencies and the N.S.F. program for physical facilities.

The financing of major research equipment at ISU has been a shared venture since the federal agencies began supporting such activities. Since that time substantial federal, state and industrial investments have made possible annual additions to our catalog of scientific and technical equipment.

Our inventory shows the ISU research equipment base is valued at $34,668,995. We estimate that more than $25 million of our current asset was financed by federal government programs.

As the above numbers indicate, Iowa State University has built its base research infrastructure with the combined support of the federal and state governments as well as industry. Unfortunately, the level of research demand being placed on ISU, as a major regional research institution, exceeds our capacity to respond. By the federal government we are being asked to:

1) increase the production of highly trained engineers and scientists in equipment dependent fields such as biotechnology, computer engineering and materials science,

2) increase our interactions with industry to enhance the rate of technology transfer and to broaden the scope of technically based economic development activities,

3) serve as producers of basic knowledge in key areas of economic activity and,

4) perform increasing levels of advanced contract research.

In addition, by the State of Iowa we are being asked to:

1) stimulate regional economic growth through R&D activities that will lead to totally new industries and,

2) provide for increased productivity and crop diversification in the Iowa farm sector.

Industry, of course, also makes demands on our research enterprise, particularly in regard to the training of young scientists and the provision of the scientific base for new techniques.

Each of these research areas merits response, and is receiving as much attention as our research infrastructure can deliver. In general, I feel that in most research areas we are meeting the demand for both people and knowledge production with our existing research complex. Where the political economy of federal and state research facility financing is insufficient is in its allocation of resources in the support of new major R&D thrusts. Many of the research demands being made at Iowa State University require totally new research directions. These ventures are often large in their relative scale and scope. Such activities cannot be carried out by simply expanding our incrementally based state budgets nor can they be implemented by piecing together the many kinds of existing projects and programs that receive federal funding. This type of federal financing of research serves a valuable, but different, purpose. Major new research thrusts require substantial front-end capital investment in facilities and equipment coupled with a coordinated attack on research targets by key university personnel, an attack in which the best and the brightest participate.

From this perspective, it is my opinion that the responsibility for financing the base infrastructure lies with the parent organization of the University (in our case the State of Iowa) while the responsibility for financing new, major, mission-directed research thrusts should be shouldered by those making the research demand.

To illustrate my point, consider the economic potential of new silicon based and ceramic materials. The demand for these materials is already high, and it is very likely that they will provide new industrial opportunities for the U.S. economy in the next 10-15 years, if intensive research is carried out. Thus we feel that we can make a valuable contribution to the research and development leading to new silicon and ceramic materials. Ideally, we would like to embark on a major research thrust that would provide a knowledge base sufficient to stimulate the near-term production of these materials somewhere within our regional economic zone. This is an example of a natural response of an institution such as ISU to the R&D demands placed upon it. Our real capability of responding to this particular demand is, however, very limited.

To illustrate, consider the ISU Department of Chemistry and its possible role in producing these new materials. Within the ISU Department of Chemistry the intellectual resources exist to embark on a major research thrust in the development of new materials. Substantial research is already on-going in these areas financed by DOE, NSF, the State of Iowa and others. This support, which generally speaking, is provided to individual researchers, is extremely valuable and is the main reason that key people are at Iowa State. However, this support is insufficient (and inappropriate for the purpose) to allow the department to move its intellectual resources into this new area of research on a scale sufficient to provide for a major R&D effort. In addition, the building provided by the state to house chemistry cannot possibly accommodate such effort. Our existing facilities are already well-occupied by current teaching and research demands. The result is the somewhat frustrating circumstance that we are asked to stimulate technical advance through knowledge production in new research areas where we have the expertise but not the means to do it. The point here is that major new research demands, which all universities have experienced in the last few years, require more than base infrastructure support. They require support for focused research thrusts and new research configurations, which go beyond those which the university needs to fulfill its historic missions, which are adequately supported.

As I have said, it is my opinion that existing funding mechanisms, both state and federal, are sufficient to address normal infrastructural growth required for traditional teaching and research areas that are the university's responsibility. What is lacking (and this is generally not well-recognized) is support for the expansion of university infrastructure which will allow us to establish programs specifically focused on critical national and regional needs. The universities are repositories for the scientific expertise needed to attack problems of vital interest to the country, but our existing resources are not adequate to take full advantage of the scientific expertise we possess. State funding is, by and large, closely tied to the primary educational mission of the institution, and funding from federal mission agencies is incremental and broadly dispersed and thus cannot address the need for funds. Consequently, the use of HR 2823 financing for the support of base infrastructure activities will probably not help universities to meet the research demand in critical areas. In all likelihood the result of such funding would be a decrease in state support of research which would inevitably require a redistribution of funds within the university to meet basic needs. The end result would simply be a shift in base support of the university from state government to the federal government. This may or may not be a good thing, but it doesn't address the fundamental problem. To respond to this problem I recommend that the committee modify HR 2823 as follows:

1) The "University Research Facilities Revitalization Act" should be framed with the expectation that states and institutions will provide the base support to fulfill their historic missions. The programs established by this Act should not attempt to revitalize departmental or college facilities simply because a need exists; every university can show such needs. What is most needed is support for new research initiatives that address national and regional research problems in a focused way. In this sense "revitalization" implies initiation of new university research thrusts for which existing programs provide a foundation rooted in the research excellence of the university.

2) Under the Act, all facilities revitalization funding should be linked to areas of research which can demonstrate that federal investment will show an economic return over the next 20-30 years, a time frame consistent with basic research. An analysis of expected benefits should include those of human capital as well as useful knowledge and new technologies.

3) The Act should be a vehicle for interagency cooperation in research funding. Scientific and technological problems don't always neatly follow agency statement of mission guidelines. Their solution should not be impeded by artificial barriers.

This bill is welcome and long overdue. Thank you for the opportunity to offer comment.

DANIEL JOSEPH ZAFFARANO

Daniel J. Zaffarano has served as Vice President for Research and Dean of the Graduate College at Iowa State University since March 15, 1971.

Born December 16, 1917 in Cleveland, Ohio, Dr. Zaffarano received his B.S. degree from Case Institute of Technology in 1939. His M.S. and Ph.D. degrees were awarded by Indiana University in 1948 and 1949.

Before joining the Iowa State staff, he was a research physicist with the National Carbon Company from 1939 to 1945, a contract administrator for the Johns Hopkins Applied Physics Laboratory from 1945 to 1946, and a graduate fellow at Indiana University from 1946 to 1949.

Dr. Zaffarano came to Iowa State as Associate Professor in 1949, was appointed Professor in 1957, and Chairman of the Department of Physics in 1961. He was reappointed Chairman in 1965 and 1970, and was awarded the title of Distinguished Professor in the College of Sciences and Humanities in 1967. He served as Physics Division Chief of the Ames Laboratory of the Atomic Energy Commission during the period 1961-1971.

The author of 25 papers in scientific journals, two patents, plus many articles, he is a Fellow of the American Physical Society and a member of Sigma Xi and Phi Kappa Phi honoraries. Courses he has taught include elementary general physics, reactor theory, nuclear physics, musical acoustics, and electricity and magnetism. He has directed the theses of ten M.S. and 14 Ph.D. students.

Dr. Zaffarano was scientific liaison officer for the Office of Naval Research, attached to the American Embassy in London, in 1957 and 1958. He has been a consultant in several programs in the National Science Foundation, the National Academy of Sciences, the U.S. Office of Education, the American Institute of Physics, and has been a Consultant-Examiner for the North Central Association of Colleges and Universities since 1969. He was a member of the Policy Research and Analysis Advisory Committee of the National Science Foundation (1979-83).

He has served as a member of the Board of Trustees of the Argonne Universities Association (1969-75), the Universities Research Association for the Fermilab (1973-76), the Iowa Power and Light Company (1973-   ), and the Executive Committee of the Council on Research Policy and Graduate Education of the Land Grant Association (NASULGC) (1978-82). He served as Division Chief of the Iowa Coal Research Project in the ISU Energy and Mineral Resources Research Institute (1974-77). He was the Iowa representative on the Board of Directors of the Mid-American Solar Energy Complex (1978-82). He has been appointed by the Governor to a committee whose goal is to attract high technology industry to Iowa.

In 1975-76 he was Chairman of the Graduate Deans group in the Mid-America State Universities Association and Chairman of the Midwestern Association of Graduate Schools. He has been a member of the Board of Directors of the Council of Graduate Schools in the United States since 1975, and served as national Chairman in 1979-80.

Zaffarano served two terms as president of the Ames Choral Society, 1965-66 and 1971-72, and was director of the Ames Town and Gown Association, 1964-65.

He and his wife, the former Suzanne Kirkham of Winston-Salem, N.C., have six children.

February 1985

Mr. **Walgren**. Thank you very much, Dr. Zaffarano.

Dr. Nicholson.

Mr. **Nicholson**. Thank you, Mr. Chairman, ladies and gentlemen. I am Tom Nicholson. I have the honor to be the Director of the American Museum of Natural History in New York City. I also represent a group of other institutions, all of which are members of an organization called the Associated Natural Science Institutions.

Most everybody loves or likes museums. All of us remember from our youth, from our student days, the things we saw and learned in them. But not too many museum-goers understand and recognize the kind of research and the kind of training which take place in museums such as ours. The American Museum of Natural History is by no means typical of all museums, nor probably even of all natural history museums. But we are typical of the institutions I represent in our consortium. Right now we have about 55 doctoral-level scholars working in full-time residence at the American Museum on their own research projects, and another 100 similar people who work in collaboration with them but hold faculty appointments at other institutions.

Every one of these persons could easily hold tenured professorships at major research universities. We presently have 12 young scholars studying with us in our laboratories and on our collections toward their doctoral degrees, and the number may vary at any given time from perhaps 10 or 12 to as many 20 or 30.

Finally, we receive almost $2 million in Federal funds annually to assist in our research activities. The colleagues that share my work in the institutions I represent can tell you similar information about their institutions.

As museums go, ours is pretty big. We have about a million and a half square feet of floor space. We spend somewhere around $43 million per year, and we have a staff of about 600 employees.

Now, that doesn't really fool me, because that's about equal to the economic scale of one 747 aircraft flying for about 3½ months. It earns just about as much money as we do in a year.

Nevertheless, the share of our resources that we allocate to research and to the training of graduate students is equal to, and in many cases greater than, the share of resources given to research and to training of graduate students at many colleges and universities.

The members of our association believe that H.R. 2823 is very significant legislation because it does identify a Federal role in basic research and graduate training that includes the shared support for facilities which research and training require and in which they take place. We hope that the bill will become law and will make this sharing of support available to institutions that carry out its purposes.

But with all due respect, we think that the agencies that will benefit from this legislation should not be limited to colleges and universities by specific name. We understand the goal in putting Federal funds where they will do the most good in terms of national interest. We also agree that the floodgates can't simply be opened to allow these funds to be available anywhere without nickel and diming them to death.

But it seems to us that the very nature of the legislation and the purposes that it describes for itself suggest that qualified institutions should be identified by what they do rather than by what they are called. I call your attention to the criteria on page 5. These are the very things that we do in our institution with at least a third of our resources. We believe that all qualified institutions which meet the criteria, identified on page 5 as an example, should be encouraged to compete for the funds that may be available through this legislation. If our institutions cannot meet the competition in terms of what they do, well, we should be rooted out, but not in the law, rather in the competition and in the review process.

It is appropriate, we believe, to set aside Federal funds for important national purposes, and this bill proposes that this be done. It proposes it by reserving a certain share of agencies' basic research budgets for the infrastructure needs of certain kinds of institutions. By the same token, however, we think it is inappropriate to set aside Federal funds lightly for certain types of institutions rather than for the purposes that they perform. The recent difficulty that arose over small business set-asides should have taught that this kind of lesson can have serious consequences.

Who then should really be permitted to compete for facilities under this legislation? Let me quote very briefly from the finding in section 2 of the bill:

> The Congress finds that fundamental research and related educational programs supported by the Federal Government and conducted by the Nation's universities and colleges are essential to national security, and to our health, economic welfare, and general well-being.

Well, Mr. Chairman, I agree, and the members of the consortium I represent agree that research and education do indeed serve important national purposes. We argue only that fundmental research and related educational programs of significance and consequence wherever they may be conducted—not just at universities and colleges—are what are critical to the Nation's security and welfare. That's what needs infrastructure support—the programs—not specifically one kind of institution. Indeed, the need may be even greater in some nonuniversity institutions than it may be in some colleges and universities.

And incidentally, I don't think that what I propose will open up the floodgates very wide if the benefits of the bill are broadened to cover all institutions that cover basic research and provide related educational programs. If "related educational programs" means graduate training, which it does in most research-oriented institutions, and which most such institutions consider to be part of their basic responsibility, you might find that the limitation would be more restrictive than one which identifies the institutions by the names "college and university."

In summary, our institutions—and by them I mean the institutions that I represent in the Associated Natural Science institutions, and I am sure there are other similar ones—serve the national interest in scientific research and related educational services in the same precise way that colleges and universities do. We conduct high-quality research. We train graduate students. We share in the research awards that are granted by the same agencies that would be affected by this legislation, and we share the same burden in creating and supporting our infrastructure from local and private sources as do colleges and universities. The only thing we don't do is grant degrees.

Let me conclude by saying again that our institutions agree that H.R. 2823 is important and that it or something like it must pass before our Nation's capacity to conduct fundamental research becomes severely restricted through crumbling or outmoded research infrastructure facilities. We argue that the purposes of the bill are important, but we argue also that all such institutions as can perform in the national interest in meeting those purposes should be permitted to compete for the benefits of the legislation.

Thank you.

[The prepared statement of Mr. Nicholson follows:]

The Associated National Science Institutions

Museum of Natural History of Los Angeles County
Academy of Natural Sciences of Philadelphia
California Academy of Natural Sciences
American Museum of Natural History
Field Museum of Natural History

499 South Capitol Street, S.W. - Suite 103
Washington D.C. 20003

Testimony on H.R. 2823
"University Research Facilities Revitalization Act of 1985"

for

Subcommittee on Science, Research & Technology
United States House of Representatives

October 24, 1985

Dr. Thomas D. Nicholson, President
The American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

Mr. Chairman, members of the Subcommittee, I am Thomas D. Nicholson, Director of the American Museum of Natural History in New York City. I appreciate this opportunity to testify. In addition to the American museum, I am honored to present the views of The Associated Natural Science Institutions, a consortium of natural history museums distinguished by their commitment to basic research and graduate training. The members of our consortium are listed on the cover sheet of this testimony.

It is a truism, I think, that everyone loves museums. Who as a child hasn't marvelled at the dinosaur skeleton and the great blue whale? But few museum lovers know about the scientific investigations that take place in our institutions, or about the graduate students who prepare for their advanced degrees in our laboratories.

The American Museum may not be typical of all natural history museums but it is typical of those in our consortium. Presently we have 55 Ph.D scientists all of whom would qualify for tenured professorships at major research universities. We have 12 young scholars who are studying for their doctoral degrees, eight matriculated at Columbia and four at the City University. Finally, we have nearly $2 million in federally sponsored research grants. My colleagues in our consortium can provide you with similar information about their institutions.

The members of The Associated Natural Science Institutions believe that H.R 2823 is a very significant legislation because it identifies a federal role in basic research and graduate training that includes the shared support for the facilities in which the research and training take place. We sincerely hope that the bill becomes law with or without the change that we propose.

With all due respect, however, we believe that the beneficiaries of the bill should not be limited to colleges and universities. We understand the goal in putting federal money where it will do the most good. Furthermore, we agree that the flood gates can't be opened to allow federal funds to be frittered away, a nickel here and a dime there. But it seems to us that the very nature of the legislation suggests that qualified institutions should be identified by what they do rather than by what they are called. All qualified institutions should be encouraged to compete. If our institutions cannot meet the competition, we should be rooted out, not in the law, but in the review process.

It is appropriate, we believe, to set aside federal funds for important national purposes and this bill would do that by reserving a small portion of agencies' basic research budgets for the infrastructure needs of their grantees and contractors. By the same token, however, we think in is inappropriate to set aside federal funds for certain types of institutions. The recent fight over small business set asides should have taught us that lesson. Any institution that can meet the objectives described in the legislation should be permitted to compete. Anything less is a prescription for abusive set asides.

Who then should be permitted to compete for facilities under this legislation? Let me quote from the first "Finding" in section 2 of the bill:

> "The Congress finds that the fundamental research and related educational programs supported by the Federal Government and conducted by the Nation's universities and colleges are essential to our national security, and to our health, economic welfare, and general well-being;..."

Mr. Chairman, we agree that research and education serve important national purposes; we argue only that fundamental research and related educational programs, wherever they are conducted, not just at universities and colleges, are critical to the nation and warrant federal infrastructure support!

Incidentally, I don't think you will open the flood gates very wide if you broaden the benefits to the bill to all institutions that conduct basic research and related educational programs. If "related educational programs" means graduate training programs, you may find that limitation to be more restrictive than the one currently in the bill.

In summary, our institutions, and I am sure there are others, serve the national interest in scientific research and related education in the same precise way that colleges and universities do. They conduct high quality research. They train graduate students. The only thing they don't do is grant degrees.

Let me conclude by saying again that our institutions agree that H.R. 2823 is important and that it or something like it must pass before our nation's capacity to conduct fundamental research is severely restricted. We argue only that all of those who can perform in the national interest should be permitted to compete.

NOC: 10/22/85

Mr. **Walgren**. Thank you very much, Dr. Nicholson. We appreciate that.

Let's go then to Dr. DeShaw.

Mr. **DeShaw**. Thank you, Mr. Chairman.

My name is James DeShaw. I am professor of life science at Sam Houston State University in Huntsville, TX. I appreciate this opportunity to appear before the Subcommittee of the House on Science, Research and Technology. We in Texas support H.R. 2823, the University Research Facilities Revitalization Act of 1985.

Mr. Chairman, the information that was presented to the House of Representatives in June by Representative Fuqua of Florida summarizes the current situation that exists in higher education today. The basic question is, can we expect our universities to be competitive in an international level without the essential equipment and facilities?

The answer is becoming more apparent with each passing day. We are routinely seeing other countries of the world pass us in areas of science and technology. It is indeed sad to see our research efforts in the shadows of other Nations throughout the world. We have built a system of private and public colleges and universities that is respected throughout the entire world. One only needs to look at the number of international students that pursue advanced studies in our country to substantiate that claim.

However, we have not systematically planned laboratory and research equipment as it becomes obsolete. Much of the equipment at universities today was purchased years ago and is currently not state-of-the-art. Though I have not heard much of the previous testimony, it has probably come from larger research institutions of this country. Those institutions certainly do have needs for modern equipment.

There is another level of universities that also needs state-of-the-art laboratory equipment. This includes institutions that have a role and scope that involve construction, research, and service, but are primarily instructional. The total research expenditures for these institutions is often less than 10 percent of their total expenditures.

However, these institutions offer advanced degrees and frequently serve regional needs. The faculties of these institutions are classmates of faculty members at institutions with a role and scope that include greater involvement in research. Faculty members of these second-tier schools must continue scholarly and research efforts. It is essential to keep them current in their field and to provide a mechanism to educate the college and university students. The faculty members at these schools do contribute and will continue to contribute if they are provided support.

In addition, these colleges and universities provide larger, more prestigious universities with graduate students, professional schools with good students, and society with educated and trained persons. It is essential that these institutions maintain a research effort.

As a matter of perspective so that the committee might better understand the general position and some of the frustrations that faculty members in the 40- to 50-year age category face today, permit me to reflect briefly on their teenage years.

For the most part, this group of faculty members spent a portion of the 1950's in high school. This was just prior to the advent of space exploration. I recall very vividly attending a regional science fair in which Dr. James Van Allen of the University of Iowa presented a lecture on the future of space research.

During the next several years, it was a time when we worked together to establish an effort that made our country a leader in the area of science and technology. That effort continued through the 1960's, and then began to decline such that during the last 10 or so years we have been very rapidly losing that leadership position. Countries like Japan, West Germany, the Soviet Union, France, and other countries have had much higher growth rates in the area of research expenditures.

Many faculty members in the prime of their productive years have become somewhat frustrated because of the inability to work in well-equipped laboratories with state-of-the-art equipment. Somehow we have to reverse this trend. The University Research Facilities Revitalization Act of 1985 offers the best hope that we have seen in years.

Within the last few years we have seen a greater emphasis on what we call university-industrial partnerships. These partnerships involve some type of sharing of research obligations as well as delivering more quickly to the industrial setting the applications of the research that have been done by universities. Traditionally, universities have done mainly basic research whereas industries have been more interested in applied research and product development.

In that no one exists in a vacuum or in isolation, in 1985 it has become apparent that the Federal Government, the colleges and universities, and industries must work together as a team so that this entire country can be competitive in science and technology. H.R. 2823 encourages industrial linkages as well as sets the groundrules for sharing the costs of providing modern equipment.

The concept of 50-50 sharing of what our university calls a matching concept generally works well. For the Federal Government it means helping provide a dollar's worth of equipment for a 50-cent investment. The university or college is the recipient of the equipment and thus can provide the facilities and environment for its faculty research team and students for 50 cents on the dollar. Industries will be much more willing to participate in a sharing of costs as opposed to paying the entire cost of new equipment.

Basically, this bill provides an incentive for all three entities involved—colleges, universities, and other groups that have worked with matching concepts—find that they are much more acceptable than having one person or group pay the entire cost.

Mr. Chairman, I cannot make the point strongly enough that the future of this country is dependent upon a strong educational system. It is basically the heart and soul and lifeblood of our future. Scientific discoveries, technological advancements, along with meeting the humanistic and artistic needs will keep our country in a leadership position for the years ahead.

We hope that the Congress of this country will continue to provide the support and incentive that allows our educational system to maintain the position that everyone has worked so hard to attain.

Mr. Chairman and members of the committee, the State of Texas is experiencing a metamorphosis in terms of its economic base. For years, up until the last couple of years, our State has been very dependent upon oil and gas revenues to support the various needs of our State. That picture is beginning to change. The price of crude oil is less than what it was a few years ago. Conservation measures that have been implemented have created a demand that is not growing as rapidly as what it did a decade or two ago.

Our State is looking toward a more diversified and probably different economic base. Our State, like many other States, is looking for ways to provide an incentive to establish high-tech research installations. The Houston area, the San Antonio area, the Dallas-Fort Worth area, and other areas of our State, we are witnessing a growing interest in science and technology.

In the last session of the Texas Legislature, some $35 million was set aside to be used on university campuses for projects that not only promote science and technology but also had the possibility of expanding our economic base. A total of over 500 proposals were submitted for this competition, with some 87 proposals receiving funding. Of that $35 million, two-thirds of it went to the Texas A&M and the University of Texas system, and the other one-third went to institutions outside of those two systems. In my mind, that is proof positive that the State of Texas is interested in working cooperatively with industry, the Federal Government, and with agencies within the State to enhance the high technology of this country.

Although one individual cannot speak for the leadership of a given State, I feel very confident that we can do our share and pay our 50 percent of the costs of revitalizing the research laboratories and technical equipment that is needed in our State. We need the assistance of H.R. 2823 to complement the efforts of our State.

Two days ago, our local newspaper carried an article about the possibility of a high-speed train between Dallas-Fort Worth area and the Greater Houston area. The article depicted a bullet-type train that would make the trip, some 250 miles, in less than 2 hours. The article further noted that it was not a United States company and concern that was looking at this endeavor, but rather a company headquarted in another country; namely, Germany.

The examples that were cited in this newspaper article included some from Japan. We might ask ourselves why is it that our scientists, our engineers, and our technical experts are not undertaking this study? Although my field is science and not economics, the next obvious question is, "What do these endeavors do for the balance of payments, inflation, employment, et cetera?"

The proposed University Facilities Revitalization Act of 1985 is possibly the silver lining of a dark cloud. Provisions of the act can and will make a big difference in the universities of this country. In my opinion, the faculties have the potential, are eager to participate, and are simply in need of support and incentive to do the job.

The provisions of this act will stimulate Federal, State, and industrial cooperation that can serve as a catalyst or lever or an enzyme to improve the university research facilities and equipment. In the process, it will stop the deterioration that we have witnessed over the past 10 or 15 years and ultimately have as its effect increased productivity, the possibility of improving the living standards, the improvement of the quality of life, and most of all, permit us to return to an appropriate competitive spirit that our country has always enjoyed.

I appreciate the opportunity to visit with you this afternoon. I would answer any questions you may have.

[The prepared statement of Mr. DeShaw follows:]

STATEMENT

OF

JAMES R. DESHAW, Ph.D.

PROFESSOR OF LIFE SCIENCES
SAM HOUSTON STATE UNIVERSITY

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

OCTOBER 24, 1985

MY NAME IS JAMES R. DESHAW. I AM A PROFESSOR OF LIFE SCIENCES AT SAM HOUSTON STATE UNIVERSITY IN HUNTSVILLE, TEXAS. I APPRECIATE THIS OPPORTUNITY TO APPEAR BEFORE THIS SUBCOMMITTEE OF THE HOUSE ON SCIENCE, RESEARCH AND TECHNOLOGY. WE IN TEXAS SUPPORT H. R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985.

MR. CHAIRMAN, THE INFORMATION THAT WAS PRESENTED TO THE HOUSE OF REPRESENTATIVES IN JUNE OF THIS YEAR BY REPRESENTATIVE FUQUA OF FLORIDA SUMMARIZED THE CURRENT SITUATION THAT EXISTS IN HIGHER EDUCATION TODAY. THE BASIC QUESTION IS: "CAN WE EXPECT OUR UNIVERSITIES TO BE COMPETITIVE ON AN INTERNATIONAL LEVEL WITHOUT THE ESSENTIAL EQUIPMENT AND FACILITIES?" THE ANSWER IS BECOMING MORE APPARENT WITH EACH PASSING DAY. WE ARE ROUTINELY SEEING OTHER COUNTRIES OF THE WORLD PASS US IN AREAS OF SCIENCE AND TECHNOLOGY. IT IS INDEED SAD TO SEE OUR RESEARCH EFFORTS IN THE SHADOW OF THOSE OF OTHER NATIONS THROUGHOUT THE WORLD. WE HAVE BUILT A SYSTEM OF PRIVATE AND PUBLIC COLLEGES AND UNIVERSITIES THAT IS RESPECTED THROUGHOUT THE ENTIRE WORLD. ONE ONLY NEEDS TO LOOK AT THE NUMBER OF INTERNATIONAL STUDENTS THAT PURSUE ADVANCED STUDIES IN THIS COUNTRY TO SUBSTANTIATE THAT CLAIM. HOWEVER, WE HAVE NOT SYSTEMATICALLY PLANNED TO REPLACE LABORATORY AND RESEARCH EQUIPMENT AS IT BECOMES OBSOLETE. MUCH OF THE EQUIPMENT AT UNIVERSITIES TODAY WAS PURCHASED YEARS AGO AND IS CURRENTLY NOT STATE-OF-THE-ART.

ALTHOUGH I HAVE NOT HEARD MUCH OF THE PREVIOUS TESTIMONY, IT HAS PROBABLY COME FROM THE LARGE RESEARCH INSTITUTIONS OF THIS COUNTRY. THOSE INSTITUTIONS CERTAINLY DO HAVE NEEDS FOR MODERN EQUIPMENT. THERE IS ANOTHER LEVEL OF UNIVERSITIES THAT ALSO NEEDS STATE-OF-THE-ART LABORATORY EQUIPMENT. THIS INCLUDES INSTITUTIONS THAT HAVE A ROLE AND SCOPE THAT INVOLVE INSTRUCTION, RESEARCH AND SERVICE BUT ARE PRIMARILY INSTRUCTIONAL. THE TOTAL RESEARCH EXPENDITURE

FOR THESE INSTITUTIONS IS OFTEN LESS THAN TEN PERCENT OF THE TOTAL EXPENDITURE; HOWEVER, THESE INSTITUTIONS OFFER ADVANCED DEGREES AND FREQUENTLY SERVE REGIONAL NEEDS. THE FACULTIES OF THESE INSTITUTIONS ARE CLASSMATES OF FACULTY MEMBERS AT INSTITUTIONS WITH A ROLE AND SCOPE THAT INCLUDE GREATER INVOLVEMENT IN RESEARCH. FACULTY MEMBERS AT THESE "SECOND TIER" SCHOOLS MUST CONTINUE SCHOLARLY AND RESEARCH EFFORTS. IT IS ESSENTIAL TO HELP KEEP THEM CURRENT IN THEIR FIELD AND TO PROVIDE A MECHANISM TO EDUCATE THE COLLEGE AND UNIVERSITY STUDENTS. FACULTY MEMBERS AT THESE SCHOOLS DO CONTRIBUTE AND WILL CONTINUE TO CONTRIBUTE IF THEY ARE PROVIDED SUPPORT. IN ADDITION, THESE COLLEGES AND UNIVERSITIES PROVIDE THE LARGER, MORE PRESTIGOUS UNIVERSITIES WITH GRADUATE STUDENTS; PROFESSIONAL SCHOOLS WITH GOOD STUDENTS; AND SOCIETY WITH EDUCATED AND TRAINED PERSONS. IT IS ESSENTIAL THAT THESE INSTITUTIONS MAINTAIN A RESEARCH EFFORT.

MR. CHAIRMAN, AS A MATTER OF PERSPECTIVE, SO THAT THE COMMITTEE MIGHT BETTER UNDERSTAND THE GENERAL POSITION AND SOME OF THE FRUSTRATIONS THAT FACULTY MEMBERS IN THE FORTY TO FIFTY YEAR OLD CATEGORY FACE TODAY, PERMIT ME TO REFLECT BRIEFLY ON THEIR TEENAGE YEARS. FOR THE MOST PART, THIS GROUP OF FACULTY MEMBERS SPENT A PORTION OF THE 1950'S IN HIGH SCHOOL. THIS WAS JUST PRIOR TO THE ADVENT OF SPACE EXPLORATION. I RECALL VERY VIVIDLY ATTENDING A REGIONAL HIGH SCHOOL SCIENCE FAIR IN WHICH DR. JAMES VAN ALLEN OF THE UNIVERSITY OF IOWA PRESENTED A LECTURE ON THE FUTURE OF SPACE RESEARCH. DURING THE NEXT SEVERAL YEARS, IT WAS A TIME WHEN WE WORKED TOGETHER TO ESTABLISH AN EFFORT THAT MADE OUR COUNTRY A LEADER IN THE AREA OF SCIENCE AND TECHNOLOGY. THAT EFFORT CONTINUED THROUGH THE 1960'S AND THEN BEGAN TO DECLINE SUCH THAT DURING THE LAST TEN OR SO YEARS, WE HAVE BEEN VERY RAPIDLY LOSING THAT LEADERSHIP POSITION. COUNTRIES LIKE JAPAN, WEST GERMANY, THE SOVIET UNION, FRANCE AND OTHER COUNTRIES HAVE HAD MUCH HIGHER GROWTH RATES IN THE AREA OF RESEARCH EXPENDITURES. MANY FACULTY MEMBERS IN THE PRIME OF THEIR PRODUCTIVE YEARS HAVE BECOME SOMEWHAT FRUSTRATED BECAUSE

OF THE INABILITY TO WORK IN WELL-EQUIPPED LABORATORIES WITH STATE-OF-THE-ART EQUIPMENT. SOMEHOW, WE HAVE TO REVERSE THAT TREND. THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985 OFFERS THE BEST HOPE THAT WE HAVE SEEN IN YEARS.

WITHIN THE LAST FEW YEARS, WE HAVE SEEN GREATER EMPHASIS ON WHAT WE CALL UNIVERSITY INDUSTRIAL PARTNERSHIPS. THESE PARTNERSHIPS INVOLVE SOME TYPE OF SHARING OF RESEARCH OBLIGATIONS AS WELL AS DELIVERING MORE QUICKLY TO THE INDUSTRIAL SETTING THE APPLICATIONS OF RESEARCH THAT HAS BEEN DONE BY UNIVERSITIES. TRADITIONALLY, UNIVERSITIES HAVE DONE MAINLY BASIC RESEARCH, WHEREAS INDUSTRIES HAVE BEEN MORE INTERESTED IN APPLIED RESEARCH AND PRODUCT DEVELOPMENT. IN THAT NO ONE EXISTS IN A VACUUM OR IN ISOLATION, IN 1985 IT HAS BECOME APPARENT THAT THE FEDERAL GOVERNMENT, THE COLLEGES AND UNIVERSITIES, AND INDUSTRIES MUST WORK TOGETHER AS A TEAM SO THAT THIS ENTIRE COUNTRY CAN BE COMPETITIVE IN SCIENCE AND TECHNOLOGY. H. R. 2823 ENCOURAGES THE INDUSTRIAL LINKAGE AS WELL AS SETS THE GROUND RULES FOR SHARING THE COST OF PROVIDING MODERN EQUIPMENT.

THE CONCEPT OF 50-50 SHARING, OR WHAT WE AT OUR UNIVERSITY HAVE CALLED A MATCHING CONCEPT, GENERALLY WORKS WELL. FOR THE FEDERAL GOVERNMENT, IT MEANS HELPING PROVIDE A DOLLARS WORTH OF EQUIPMENT FOR A FIFTY CENT INVESTMENT. THE UNIVERSITY OR COLLEGE IS THE RECIPIENT OF THE EQUIPMENT AND THUS CAN IMPROVE THE FACILITIES AND ENVIRONMENT FOR ITS FACULTY RESEARCH TEAM AND STUDENTS FOR FIFTY CENTS ON THE DOLLAR. INDUSTRIES WILL BE MUCH MORE WILLING TO PARTICIPATE IN THE SHARING OF COSTS AS OPPOSED TO PAYING THE ENTIRE COST OF NEW EQUIPMENT. BASICALLY, THIS BILL PROVIDES INCENTIVE FOR ALL THREE ENTITIES INVOLVED. UNIVERSITIES, COLLEGES AND OTHER GROUPS THAT HAVE WORKED WITH MATCHING CONCEPTS FIND THAT THEY ARE MUCH MORE ACCEPTABLE THAN HAVING ONE PERSON OR GROUP PAY THE ENTIRE COST.

MR. CHAIRMAN, I CANNOT MAKE THE POINT STRONG ENOUGH THAT THE FUTURE OF

THIS COUNTRY IS DEPENDENT UPON A STRONG EDUCATIONAL SYSTEM. IT IS BASICALLY THE HEART, soul SOLE, AND THE LIFE BLOOD OF OUR FUTURE. SCIENTIFIC DISCOVERIES AND TECHNOLOGICAL ADVANCEMENTS ALONG WITH THE MEETING OF HUMANISTIC AND ARTISTIC NEEDS WILL KEEP OUR COUNTRY IN A LEADERSHIP POSITION IN THE YEARS AHEAD. WE HOPE THAT THE CONGRESS OF THIS COUNTRY WILL CONTINUE TO PROVIDE THE SUPPORT AND INCENTIVE THAT ALLOWS OUR EDUCATIONAL SYSTEMS TO MAINTAIN THE POSITION THAT EVERYONE HAS WORKED SO HARD TO OBTAIN.

MR. CHAIRMAN, MEMBERS OF THE COMMITTEE, THE STATE OF TEXAS IS EXPERIENCING A METAMORPHOSIS IN TERMS OF ITS ECONOMIC BASIS. FOR YEARS, UP UNTIL THE LAST COUPLE OF YEARS, OUR STATE HAS BEEN VERY DEPENDENT UPON OIL AND GAS REVENUES TO SUPPORT THE VARIOUS NEEDS OF OUR STATE. THAT PICTURE IS BEGINNING TO CHANGE. THE PRICE OF CRUDE OIL IS LESS THAN WHAT IT WAS A FEW YEARS AGO. THE CONSERVATION MEASURES THAT HAVE BEEN IMPLEMENTED ARE CREATING A DEMAND THAT IS NOT GROWING AS RAPIDLY AS ~~WHAT~~ IT DID A DECADE OR TWO AGO. OUR STATE IS LOOKING TOWARD A MORE DIVERSIFIED AND PROBABLY A DIFFERENT ECONOMIC BASE. OUR STATE, LIKE MANY OTHER STATES, IS LOOKING FOR WAYS TO PROVIDE AN INCENTIVE TO ESTABLISH HIGH TECH RESEARCH INSTALLATIONS. IN THE HOUSTON AREA, IN THE SAN ANTONIO AREA, IN THE DALLAS-FORT WORTH AREA, AND IN OTHER AREAS OF OUR STATE, WE ARE WITNESSING A GROWING INTEREST IN SCIENCE AND TECHNOLOGY.

IN THE LAST SESSION OF ~~OUR~~ LEGISLATURE, SOME $35 MILLION WERE SET ASIDE TO BE USED ON UNIVERSITY CAMPUSES FOR PROJECTS THAT NOT ONLY PROMOTED SCIENCE AND TECHNOLOGY, BUT ALSO HAD THE POSSIBILITY OF EXPANDING OUR ECONOMIC BASE. A TOTAL OF OVER 500 PROPOSALS WERE SUBMITTED FOR THIS COMPETITION WITH SOME 87 PROPOSALS RECEIVING FUNDING. OF THAT, $35 MILLION, TWO-THIRDS OF IT WENT TO THE TEXAS A&M AND THE UNIVERSITY OF TEXAS SYSTEMS, THE OTHER ONE-THIRD WENT TO INSTITUTIONS OUTSIDE OF THOSE TWO SYSTEMS. IN MY MIND, THAT IS PROOF POSITIVE THAT THE STATE OF TEXAS IS INTERESTED IN WORKING COOPERATIVELY WITH INDUSTRY, THE FEDERAL GOVERNMENT AND WITH AGENCIES WITHIN THE STATE TO ENHANCE HIGH TECHNOLOGY FOR THIS COUNTRY. ALTHOUGH ONE INDIVIDUAL CANNOT SPEAK FOR THE LEADERSHIP OF A GIVEN STATE, I FEEL VERY CONFIDENT THAT WE CAN DO OUR SHARE AND PAY OUR FIFTY PERCENT OF THE COST TO REVITALIZE THE RESEARCH LABORATORIES AND TECHNICAL EQUIPMENT THAT IS NEEDED IN OUR STATE. WE NEED THE ASSISTANCE OF H. R. 2823 TO COMPLIMENT THE EFFORTS OF OUR STATE.

TWO DAYS AGO, OUR LOCAL NEWSPAPER CARRIED AN ARTICLE ABOUT THE POSSIBILITY OF A HIGH SPEED TRAIN BETWEEN THE DALLAS-FORT WORTH AREA AND THE GREATER HOUSTON AREA. THE ARTICLE DEPICTED A BULLET TYPE TRAIN THAT WOULD MAKE THE TRIP SOME 250 MILES IN LESS THAN TWO HOURS. THE ARTICLE FURTHER NOTED THAT IT WAS NOT A UNITED STATES COMPANY AND CONCERN THAT WAS LOOKING AT THIS ENDEAVOR, BUT RATHER A COMPANY THAT WAS HEADQUARTERED IN ANOTHER COUNTRY, NAMELY, GERMANY. THE EXAMPLES THAT WERE CITED IN THIS NEWSPAPER ARTICLE INCLUDED SOME FROM JAPAN. WE MIGHT ASK OURSELVES WHY IS IT THAT WE, OUR SCIENTISTS, OUR ENGINEERS, OUR TECHNICAL EXPERTS ARE NOT UNDERTAKING THIS STUDY? ALTHOUGH MY FIELD IS SCIENCE AND NOT ECONOMICS, THE NEXT OBVIOUS QUESTION IS WHAT DO THOSE ENDEAVORS DO FOR THE BALANCE OF PAYMENTS, INFLATION, EMPLOYMENT, ETC., ETC.? $T_2 S_1$ /

THE PROPOSED UNIVERSITY FACILITIES REVITALIZATION ACT OF 1985 IS POSSIBLY THE SILVER LINING OF A DARK CLOUD. PROVISIONS OF THE ACT CAN AND WILL MAKE A BIG DIFFERENCE IN THE UNIVERSITIES OF THIS COUNTRY. IN MY OPINION, THE FACULTIES HAVE THE POTENTIAL, ARE EAGER TO PARTICIPATE, AND SIMPLY NEED THE SUPPORT AND INCENTIVE TO DO THE JOB. THE PROVISIONS OF THIS ACT WILL STIMULATE FEDERAL, STATE AND INDUSTRIAL COOPERATIVE PROGRAMS THAT CAN SERVE AS A CATALYST, OR A LEVER, OR AN ENZYME TO IMPROVE THE UNIVERSITY RESEARCH FACILITIES AND EQUIPMENT. IN THE PROCESS, IT WILL STOP THE DETERIORATION THAT WE HAVE WITNESSED OVER THE LAST TEN TO FIFTEEN YEARS AND WILL ULTIMATELY HAVE, AS ITS EFFECT, INCREASED PRODUCTIVITY, THE POSSIBILITY OF IMPROVING THE LIVING STANDARDS, THE IMPROVEMENT OF THE QUALITY OF LIFE, AND MOST OF ALL, PERMIT US TO RETURN TO THE APPROPRIATE COMPETITIVE SPIRIT THAT OUR COUNTRY HAS ALWAYS ENJOYED.

THE OPPORTUNITY TO VISIT WITH YOU THIS AFTERNOON IS APPRECIATED. THANK YOU VERY MUCH.

RESUME

October, 1985

James R. DeShaw
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Married, One Child
Birthdate: 06-19-42

EDUCATION

Loras College, Dubuque, Iowa, B.S. Degree, 1965; Major: Biology; Minor: Chemistry.
Texas A&M University, College Station, Texas, M.S. Degree, 1967; Major: Biology.
Texas A&M University, College Station, Texas, Ph.D. Degree, 1970; Major: Biology; Minor: Environmental Science.

EXPERIENCE

1964-1965	Loras College, Dubuque, Iowa, Undergraduate Teaching Assistant.
1965-1967	Texas A&M University, College Station, Texas, Graduate Teaching Assistant in Biology.
1967-1970	Texas A&M University, College Station, Texas, Half-time Research Assistant in Environmental Science.
1970-1973	Sam Houston State University, Huntsville, Texas, Assistant Professor of Biology and Environmental Science.
1973-1981	Sam Houston State University, Huntsville, Texas, Associate Professor of Biology and Environmental Science.
1981-1982	Sam Houston State University, Huntsville, Texas, Director, Faculty Research and Grants and Associate Professor of Biology and Environmental Science.
1982-1984	Sam Houston State University, Huntsville, Texas, Director, Faculty Research and Graduate Studies and Associate Professor of Biology and Environmental Science.
1984-1985	Sam Houston State University, Huntsville, Texas, Director, Faculty Research and Graduate Studies and Professor of Biology and Environmental Science.
1985-present	Sam Houston State University, Huntsville, Texas, Professor of Biology and Environmental Science

RESEARCH AND SCHOLARLY ACTIVITIES

The principal research effort has been in the area of water quality and aquatic productivity. There has been active involvement in science education and as an author of numerous publications. Research has been supported by the National Science Foundation, the State of Texas, the Texas Water Quality Board and Gulf States Utilities. Additional support for academic endeavors has been provided by private industry, cities and governmental agencies.

Mr. WALGREN. We appreciate that.

Dr. Cumming?

Dr. CUMMING. Mr. Chairman and members of the Subcommittee on Science, Research and Technology, thank you for inviting me to present my views and those of the American Red Cross on the subject of revitalizing university research facilities.

I am Paul Cumming. I am director of market research and support within the research, development and marketing department of the American Red Cross national headquarters—for those of you who don't have an agenda. My testimony is divided into two parts, the first entitled "Funding Needed by Not-for-Profit Organizations," the second, "Activities of the American Red Cross." With that, I will begin the first part.

First and foremost, we agree with the committee that there is a desperate need to revitalize our nonprofit educational research institutions and that a major part of this revitalization effort must be directed at the funding of capital as opposed to operating requirements. Nonprofit organizations are at a double disadvantage in the area of funding research capital requirements. Not-for-profit organizations do not have as strong an ability to acquire funds from capital markets as do some other sectors of the economy. In addition, the humanitarian leanings of much of the not-for-profit sector leads to a tendency to overemphasize funding of staff and related expenses and underfunding of capital items. The result frequently is less than optimal research productivity. Maximum social welfare can only be achieved through maximizing productivity by properly balancing or blending labor and capital. This is true whether we are talking about the production of goods or the production of research. The subcommittee has noted correctly in the findings section of H.R. 2823 that, "Fundamental research and related educational programs are essential to our national security and to our health, economic welfare, and general well-being."

The American Red Cross has faced head on the problem of obsolete research buildings and equipment, the second finding noted in H.R. 2823, and has found the task of solving the problem an arduous one. In our effort to adjust to changes in social needs for biomedical and educational services, we are updating, upgrading, and expanding our research facilities. Over 5 years of effort is only now culminating in acquisition of funding necessary to build modern research facilities, and we will be burdened with a large debt for the next 15 years. By taking these actions, the American Red Cross has also demonstrated concurrence with the subcommittee's findings numbered 3 and 4 of H.R. 2823: No. 3, that, "The Nation's capacity to conduct high-quality research and educational programs and to maintain its competitive position at the forefront of modern science, engineering, and technology is threatened by this research capital deficit which poses serious and adverse consequences to our future national security, health, welfare, and ability to compete in the international marketplace," and No. 4, that, "A national effort to spur reinvestment in research facilities is needed."

Successful passage of the legislation you are proposing, and inclusion of the American Red Cross as eligible for funding under the legislation, would permit the American Red Cross to devote more of our resources to conducting socially beneficial research and development and less of our resources to acquiring funding to retire our indebtedness and thus achieve a net gain in social welfare for the American people.

The next part of the presentation is under the general heading "Activities of the American Red Cross."

You know that the American Red Cross provides services to the American people in blood, disasters, the military, and in many other ways. You also know that we teach first aid, cardiopulmonary resuscitation, water safety, and other health, safety, and injury prevention courses. Less well known is that for many years we have conducted biomedical research in support of our blood services and that we are conducting research in behavioral, operational, and social science in support of our other activities. Thus, our educational and research activities are similar to those conducted in colleges and universities which are to be supported by this legislation.

More specific reasons that the American Red Cross should be considered a university or college under the definitions of the proposed legislation are as follows:

Education is the American Red Cross' biggest service. More than 6 million Americans took Red Cross health and safety training last year. Even more will take our training this year. The primary courses taken by American Red Cross students are cardiopulmonary resuscitation, first aid, and water safety. The American Red Cross' 6 million annual students is equal to one-half of the entire 1983 population of America's universities and colleges.

Last year, more than 3 million Americans benefited from lifesaving transfusions of voluntarily donated blood and blood products. Moreover, an estimated million Americans took advantage of the opportunity to donate the gift of life.

Our research skills have helped assure the validity of this gift via the safest blood supply in the world. When acquired immune deficiency syndrome, or AIDS, appeared, our research knowledge permitted us to move extremely rapidly to incorporate the best-known means of protecting recipients. When the Food and Drug Administration licensed testing for antibody to the AIDS virus, the test was used within days by the American Red Cross to screen collected blood.

Moreover, our implementation experience was captured by our scientists and reported to the scientific world to the end that donor acceptance criteria were changed by the Food and Drug Administration.

The American Red Cross is a congressionally chartered organization, thus unique, and including us under the definition of an educational institution in the proposed legislation would not open the doors to similar requests by other organizations.

Thank you for this opportunity to present the views of the American Red Cross. We applaud your efforts, and hope that you are successful in your attempt to revitalize research by educational institutions, and that you will include the American Red Cross within the definition of an educational institution.

[The prepared statement of Mr. Cumming follows:]

Testimony to the
Committee on Science and Technology
Subcommittee on Science, Research and Technology
Doug Walgren, Chairman

HR 2823,
The University Research Facilities Revitalization Act of 1985

by

Paul D. Cumming, Ph.D.
Research, Development and Marketing Department
American National Red Cross
Thursday October 24, 1985

Paul D. Cumming, Ph.D.

A Brief Bibliographical Sketch

Dr. Cumming holds a bachelors degree in business and economics, a masters in business administration with emphasis on marketing and industrial relations, and a doctorate in management systems and science. He has been with the American Red Cross for the last 3 years and currently is Director of the Market Research and Support Division of the Research, Development and Marketing Department at the National Headquarters. Prior experience includes two years of part-time university teaching, five years of university research, two years of comprehensive regional health planning and six years of commercial consulting. Writings cover more than a hundred consulting documents and many professional journal articles, including publications in Science and Medical Care. The subject matter of Dr. Cumming's writings generally addresses statistical and management issues related to health and environment.

Mr. Chairman and members of the Subcommittee on Science, Research and Technology, thank you for inviting me to present my views and those of the American Red Cross on the subject of revitalizing university research facilities.

Funding Needed By Not-For-Profit Organizations

First and foremost we agree with the subcommittee that there is a desperate need to revitalize our non profit educational research institutions and that a major part of this revitalization effort must be directed at the funding of capital, as opposed to operating, requirements. Non profit organizations are at a double disadvantage in the area of funding research capital requirements. Not-for-profit organizations do not have as strong an ability to acquire funds from the capital markets as do some other sectors of the economy. In addition, the humanitarian leanings of much of the not-for-profit sector leads to a tendency to over emphasize funding of staff and related expenses and under funding of capital items. The result frequently is less than optimal research productivity. Maximum social welfare can only be achieved through maximizing productivity by properly balancing or blending labor and capital. This is true whether we are talking about the production of goods or the production of research. The subcommittee has noted correctly in the findings sections of HR 2823, "fundamental research and related education programs . . . . are essential to our national security, and to our health, economic welfare, and general well-being."

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Successful passage of the legislation you are proposing, and inclusion of the American Red Cross as eligible for funding under the legislation, would permit the American Red Cross to devote more of our resources to conducting socially beneficial research and development, and less of our resources to acquiring funding to retire our indebtedness, and thus achieve a net gain in the social welfare of the American people.

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- The American Red Cross is a Congressionally chartered organization, thus unique, and including us under the definition of an educational institution in the proposed legislation would not open the doors to similar requests by other organizations.

Thank you for this opportunity to present the views of the American Red Cross. We applaud your efforts and hope that you are successful in your attempt to revitalize research by educational institutions and that you will include the American Red Cross within the definition of an educational institution.

Mr. **Walgren**. Well, thank you, Dr. Cumming.

We want to express our appreciation to all of you for your contribution to the record, and I think you certainly make good and finite points. The not-for-profits in the range beyond the college and the universities are a very clear issue that we will have to resolve. Certainly, there is a very good argument directly made for that.

I am tempted to ask, Dr. Zaffarano, your emphasis on new thrusts and limiting any new programs to that area would put you in the category of really not wanting to disrupt the present flow at all, I would imagine. Without putting words in your mouth—you would not be one to set aside funds presently directed toward this new-thrust effort?

Mr. **Zaffarano**. I think universities must recognize the realities of the situation, and we must be prepared to take some share of this burden ourselves. What I am thinking is that the percentage that you have identified as 10 percent may not survive, but I would believe something like a 5 percent cut would be lost essentially in the background noise of the system and that we could live with that.

I certainly would be agreeable from our university's standpoint to accept a part of this burden, and if that is true, if we cut back the percentage, say, 10 percent to 5 percent, the amount of money becomes smaller, I presume. And if it becomes smaller, it seems to me we need to focus the thrust in order to have any impact at all because I am so worried that the money will be used for creating more comfortable facilities for existing activities. To me, that's not creating an impact.

We have many examples on our campus of new things we are doing in microelectronics, for example, and nondestructive evaluation and biotechnology. All these are new things which have just evolved over the last 2 or 3 years and which are very exciting. They are very exciting, but we have no space and we have no real equipment to deal with these things in the way that we would like to in order to make an impact soon.

So what I am saying is, yes, I would be willing to go along with, say, 5-percent penalty on our research funds in order to support these new thrusts.

Mr. **Walgren**. In your view, it clearly needs to be limited in a way to those new thrusts. One of the questions that seems to remain open is, if the deciding entity or the decisionmaker about whether or not the Federal funds are to be committed or decommitted is distributed as widely as the six mission agencies and then, I would gather, distributed down through those agencies in some way because they would not necessarily be totally coordinated so that one person is looking at all the options, but rather you would probably have some distribution of authority to make that commitment down or across the range of that agency.

So you have distributed the ability to commit the Federal dollar very, very widely to a very unreachable extent, and you don't know what forces that person would be operating under, and that might lead them very much astray from a focused new-thrust national-need emphasis in the program as it presently is being discussed.

Mr. **Zaffarano**. Exactly. And I really would like to add to that point that I think that there should be in the legislation a directive—and I don't know whether you can direct these agencies to work together—but if we can somehow survive the scrutiny that this is something that really is a national need, I think that the several agencies ought to take parts of this and work together to support it rather than making a diffused dispersion of funds where there will be little impact resulting.

Mr. **Walgren**. The forces working at cross purposes are the two horns of the dilemma, on the one hand the decentralization helps you avoid some of the fear that participation in this will be so limited and focused that only the preeminent institutions will draw all the effort and therefore leave others behind. On the other hand, the more you diffuse it and spread the commitment authority throughout the bureaucracy, the less sure you are of the use that the money is going to put.

Mr. **Zaffarano**. It's a difficult problem, I am sorry to say.

Mr. **Walgren**. It strikes me that if you really focused on new thrusts, that that might solve some of the reservations that I think are on good ground that some institutions would be left out, because it's one thing to be left out of a focused new thrust, it's another thing to be left out of the general infrastructure that you need to be a successful university. And if you're left out of the second, you know, you're really left out then.

If you don't participate in the location of a very highly sophisticated focused laboratory, well, you won't have quite that window in your domain but you won't be left out of the whole field because the whole field remains. But if you're left out of the infrastructure necessary for the whole field, then you really are left out.

Mr. **Zaffarano**. It is my impression that every major university that I know of is trying to develop a research park, a silicon valley, new thrusts in biotechnology. I can't think of a university that isn't trying to do these things.

So I think that we are all creative enough that we can tell you what our new thrusts are and leave it to some peer judgment, perhaps, as to which new thrusts are most important and worth funding.

I don't think we're going to leave anybody out if we limit it to new thrusts, but we will then in the long run, I think, be able to show an impact of this bill.

Mr. **Walgren**. Well, I would like to underscore the apprehension of institutions not participating in something that is basically necessary for them to continue to be strong on the one hand, and it may be that the direction of specific new thrusts rather than general facilities is something that would help ensure us that that would not be an unintended harm that might be done.

Well, let me ask counsel for the majority and the minority if there is something really you would like to raise at this point.

Ms. **Bach**. I might ask the question, Iowa State has been engaged in a program called "Excellence in the Eighties." You have also been able to take on a major expansion of the library on campus and you've just opened a new facility and a computer for the computer facility.

Could you explain for the record or elaborate on the financing mechanisms for which you were able to pursue those, and also, what is the program "Excellence in the Eighties?"

Mr. **Zaffarano**. The program "Excellence in the Eighties" has to do with alumni contributions. I don't remember the exact numbers, but I think our alumni participation in terms of funding of facilities on our campus is about as high as any university in the country.

I am very pleased that we have this great allegiance of our alumni. Part of it is because we are completely a residential university. People live, breathe, and survive in Ames, IA. There isn't much else to do but study with the university. But we have great allegiance among our alumni.

We have a complete cultural center, which removed us from the traditional setting of a scientific and technical university into a cultural university, which was completely paid for by our alumni and friends. We have the major orchestras of the world come to Iowa State now in this new facility.

We have received major grants from alumni for a computation center, and this $10 million facility will now be built completely with alumni contributions.

We are having great difficulties in the State getting money from our legislature for new facilities. They claim that, you know, we're going to go over the top in enrollment very soon and we will have space vacant. The fact of the matter is that our enrollment this fall is 300 more than it was last year, and it has gone up every year since when the peak was supposed to be passed, which was back in 1981.

We don't foresee the end of the growth of our university. A great share of that growth comes in the graduate college as well as the undergraduate college. So that we've had difficulty this last year. The legislature requested a bonding authority for the university so that we could borrow money against future fees, student tuition. The Governor vetoed that legislation. And so we are essentially stymied for new buildings unless we use the funds that may become available through this bill or if we can go to our alumni and to foundations.

Fortunately, we are very excited about this period in our growth of Iowa State University. We have really new thrusts, things which were forced upon us by circumstances, things we ought to be doing. We identified these. We have biotechnology, as I mentioned, and micro electronics, as most universities, I should think, can say that, too. But we have received enough funding through the normal proposal refereeing process that these are viable and running now.

All we can say is we think the State and whatever other sources of funds that we have can maintain at least—I think there is some deterioration, of course—the infrastructure we have across the university. What we simply cannot do is to divert money from the teaching of students—we need every penny we can get for new faculty—from the traditional things into these new thrusts. And this is where we are having really a tough time expanding to satisfy a State need and a national need.

We are trying to work with the Department of Defense because we are building the front end of the global positioning satellite system that Rockwell is producing in Cedar Rapids, IA. We have a subcontract to produce some prototype devices for them. This is tremendously exciting. We have never done things like this before.

We need new space and silicon furnaces and things of this nature in order to get into this as deeply as we would like to. We cannot obtain those things from research grants, normally, nor from our State at the present time. So we see this bill as a great hope for the future.

Mr. **Walgren**. Thank you.

Ms. **Bach**. There was one other question I had wanted to ask, and it's about an implication, if I understand correctly, in your statement on page 7, where you say that, "In all likelihood, the result of such funding would be a decrease in State support of research which would inevitably require redistribution of funds within the university to meet basic needs."

Mr. **Zaffarano**. You're talking about me.

Ms. **Bach**. I think that that's a very critical statement. It's something that was raised at the National Academy of Science when there was an effort which was described earlier by Don Phillips to discuss the whole question of various approaches to the infrastructure.

Could you comment a little bit further on——

Mr. **Zaffarano**. I am looking at the wrong one. I am sorry.

Ms. **Bach**. Excuse me.

Mr. **Zaffarano**. Sorry. If you could tell me which section?

Ms. **Bach**. On the top of page 7, the first sentence, "In all likelihood the result of such funding would be a decrease in State support."

The reason I asked the question if you could elaborate on that is that during the conference there was various concern expressed from different States' State university representatives that Federal funds coming through certain types of awards would be seen by a State legislature as money they should not have to provide. If the Federal Government is providing certain kinds of funds, then they would consider that money to be funds they would hold back on.

Could you elaborate a little bit further if I am reading your statement to be the same implication?

Mr. **Zaffarano**. Surely. In common with many State universities, all indirect cost returns from contracts and grants at our university go into the general fund and are prebudgeted by the university, prebudgeted by the board of regents, so that this money goes into salaries.

One has the feeling that if we increase this money as it comes in, this is looked upon as a relief from the legislature's viewpoint as money that they don't have to provide. And the same sort of thing is possible here, it seems to us, that if the regular maintenance of our facilities, the putting the new roofs on the buildings, the putting air-conditioners in the buildings and so forth, if that is provided by this bill, then this will be looked upon by the State legislature as a relief from things that they normally have to provide. This worries us very much.

We really believe that it is the duty of our State to provide teaching and basic research facilities for the faculty, and the State has responded to this in the past reasonably well—not as well as we would like, ever. But if the bill were used instead of that to provide new-thrust funding for new things, then the legislature would look upon that as an addition and something they don't need to replace, you see, or something that takes the burden off them. It's something they cannot do at the present time.

So we believe that confining this to the things we would like to develop for the campus but we can't otherwise do would be more palatable to our State and would help our legislature to understand that it is their duty to provide the basic infrastructure, and the Federal Government is going to help to provide innovation in our campus.

Mr. **Walgren**. Thank you.

As a graduate of Iowa State, Ms. Bach would like to be on record as contributing through the office. [Laughter.]

Mr. **Zaffarano**. We are very proud of Ms. Bach.

Mr. **Walgren**. Dr. Heitowit?

Mr. **Heitowit**. In anticipation of some future Federal role in the support of university infrastructure and facilities, both the House-passed and Senate-passed versions of the fiscal year 1986 National Science Foundation authorization contained provisions for the Foundation to conduct a survey of academic research facility needs.

We would like to ask each of you or any of you at this point from your own interests what sort of survey data do you think NSF should collect in order to carry out successful programs in the future? Does anyone have a suggestion?

Mr. **Zaffarano**. May I? I have talked to people from the Science Foundation about this point, and what I would like to suggest is that the Science Foundation contact people like Barry Cooperman and myself who have the title of vice president for resarch at our university, who have an overview of the entire university's needs, really, in terms of research equipment.

And the way our university operates at the present time is with what money we have available for equipment, all requests funnel through my office from the whole university, and I provide guidance for our business office as to which things we can afford to match when there is matching required, which things we can afford to buy when there is no matching required.

I believe that I could put up from my university—and I haven't asked Dr. Cooperman that—but I think I could provide a list in priority order of items of facilities or equipment that we really need to carry on these things that I have been mentioning—new thrusts and maybe old thrusts as well—and that this, I could give priority order and cost.

So I think if one could just mobilize the vice presidents for research of most universities in this country, I think you could get a good idea of the answer you're requiring.

Mr. **Cooperman**. I would like to respond as well. I think what you're seeing here is a real difference in culture between State universities and the large private universities.

We have a very different system of organization. In fact, some people have likened the organization of research at a university like the University of Pennsylvania to that of a shopping mall, where the university basically holds the deed to the land and provides the heat and security and facilities, and the individual shop owners go out and get the money as best they can and set up their shops and attract the customers.

This isn't quite accurate, but it has a ring of truth to it that's not inappreciable. It's closer to the facts. We are not as centralized as the model that Dr. Zaffarano was describing, for good or for worse.

So I think certainly, although he's giving me more work to do, I would be delighted to participate with the NSF in acquiring that information. But at our university the priorities for where research money is spent is really set at a much more local level, usually at the department level, sometimes at the school level, and only rarely at the university level.

Mr. **Walgren**. Well, on behalf of our subcommittee, we certainly appreciate your contribution to the record and your being a resource to us. We appreciate the effort that goes into it, and the content as well. So thank you very much for participating.

We will let the record remain open if there may be some written followup between us and the various witnesses today. We would appreciate your help with that as well.

Thank you.

[Whereupon, at 4:38 p.m., the subcommittee was adjourned.]

H.R. 2823, THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

WEDNESDAY, OCTOBER 30, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to call, at 1:37 p.m., in room 2325, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Mr. **Walgren**. This afternoon the subcommittee continues and, at least for the present, concludes a series of hearings on the research facilities modernization issue at U.S. colleges and universities. As you know, we are receiving testimony from a variety of sources, including academic and research institutions and the major Federal R&D agencies.

We have asked our witnesses to give us their views on facility needs and any suggestions they might for an appropriate Federal response that we could consider in this area. As you know, there has been legislation introduced by the chairman of the full Science and Technology Committee, Congressman Fuqua, known as H.R. 2823, the University Research Facilities Revitalization Act. We feel this is a very important subject, one that the Congress should respond to, and we do believe that legislation will develop in this area in the very near future.

We have received a lot of requests to present testimony and have tried to accommodate some of those, but obviously we are unable to accommodate them all. I would like to encourage people to submit their views in writing at that point and the committee will certainly consider them for both inclusion in the record and also discussion among the staff and among the working sessions that will precede actual markup of a bill in this area.

But we do have a lot of witnesses this afternoon, so I want to encourage folks to summarize and outline in some way the points that they feel most important to make, because in fairness to other witnesses and the interruption that we expect because the House is in session, in fairness to those considerations I want to encourage people to limit their testimony to something in the 5 minute-plus range. And it will also help in reviewing the record to highlight the points that someone really feels are most important if they stand out in their verbal presentation. Written presentations will be incorporated and reproduced in the record as a matter of course and, therefore, you can count on what you submit in writing as being

—

part of the hearing document and the hearing record in this instance.

[The opening prepared statement of Hon. Sherwood Boehlert follows:]

Opening Statement
Honorable Sherwood Boehlert, R-NY
Subcommittee on Science, Research and Technology
October 30, 1985

Mr. Chairman, Members of the Subcommittee, ladies and gentlemen, I am pleased to have this opportunity to continue discussion of H.R 2823, the University Research Facilities Revitalization Act of 1985. We are continuing hearings, this being the fourth meeting, in an effort to establish a very accurate and complete record on the status, need and appropriate approaches to the funding of university research facilities.

Since there are several organizations, individuals and points of view to be heard on this topic, in the essence of time, Mr. Chairman, I will forgo further comment so that we can begin.

Mr. WALGREN. We certainly appreciate the witnesses that have come and their going to the effort to pull their thoughts together and be a resource to us in this process. So, with that, let me start off with the first panel. We have Marshall Criser—is that right—I apologize if I mispronounce—who is the president of the University of Florida, representing the Association of American Universities and the National Association of State Universities and Land Grant Colleges—we certainly appreciate your being here—accompanied on this panel by Dr. Vijaya Melnick, the University of the District of Columbia, on behalf of a number of others, in particular Dr. Fredrick Humphries, the president of Florida A&M University, who is the chairman of the Science Advisory Committee of the National Association for Equal Opportunity in Higher Education. Also on the panel are Dr. William Miller, president and chief executive officer of SRI in Menlo Park, CA—welcome to you, Dr. Miller. Having lived in Menlo Park for a number of years, we know you've got a wonderful place out there and we appreciate your coming back here to join in this effort. And also Dr. Charles Walker, who is the dean of the school of pharmacy at Florida A&M University.

Well, welcome to the committee, folks. We will go through the panel in the order in which I indicated your presence for the record, and would you then proceed in whatever way you feel most effective.

STATEMENTS OF MARSHALL CRISER, PRESIDENT, UNIVERSITY OF FLORIDA; VIJAYA L. MELNICK, PROFESSOR OF BIOLOGY AND SENIOR RESEARCH SCHOLAR, CENTER FOR APPLIED RESEARCH AND URBAN POLICY, THE UNIVERSITY OF THE DISTRICT OF COLUMBIA; WILLIAM F. MILLER, PRESIDENT AND CHIEF EXECUTIVE OFFICER, SRI INTERNATIONAL; AND CHARLES A. WALKER, DEAN OF THE FLORIDA A&M UNIVERSITY SCHOOL OF PHARMACY

Dr. CRISER. Thank you, Mr. Chairman.

I understand the time problem and therefore will be brief in my remarks. We have filed a written statement. On that statement are identified the organizations that I represent in these proceedings.

I will spend no time addressing the problem. We are all well aware of what the problem is. The question now is to seek a suitable solution, and it is the purpose of these presentations to commend Chairman Fuqua and the cosponsors of H.R. 2823, which we believe is a great, giant step forward in attempting to obtain a solution to this very serious problem—the problem of the lack of research facilities of modern vintage and of capacity to take care of the research now being done on university campuses for the six Federal agencies which are named in H.R. 2823.

I will then go directly to the recommendations. Let me say the Association of American Universities met last week and carefully reviewed the proposed legislation, and after a thorough discussion endorsed in principle the legislation unanimously. Again, I communicate their strong support to seek a solution to what they all know to be a very serious problem.

Having endorsed it in principle, having discussed it thoroughly, they bring to the committee certain recommendations. They have asked me to convey those to you here today.

The first recommendation to the legislation as presently drafted is to strengthen the funding mechanism in all titles of the bill so as to protect better the research programs of each agency in the event that the newly authorized funds, that $470 million referred to in the resolution, are not fully appropriated, and to provide for a structured, perhaps a 3-year implementation of the 10-percent funding requirements of the bill.

This recommendation reflects what we can understand to be the primary reservation within many of our institutions, that under certain circumstances the bill will require facilities programs to be funded entirely at the expense of ongoing research programs. We know that is not the intent of the bill. In order to give comfort to those who are concerned about that, we would suggest that that amendment take place and be incorporated in the language. We think it would strengthen the bill and the phase in would be reassuring to those who are concerned about the level of funding that might be experienced in 1987 and future years.

The second recommendation is that the matching requirement be retained—we think that's a very strong portion of the bill—but it be modified from the present 50-50 requirement to language which would say at least 25 percent but not more than 50 percent. The purpose of that suggestion frankly is just to give the universities more flexibility in working out the matching of the potential that they have, either through State funding in the case of public institutions, or in the case of private funding, for all institutions.

I had some comments to make in regard to other reinvestment strategies now before the Congress. Because of the time limitation, I will not make those comments at this time. They are included in our written presentation.

In conclusion, we face the prospects of unrelenting pressure on our research budgets. We have a difficult but unavoidable policy choice before us. On the one hand we can choose to allow the research capital deficit to worsen at its current pace. In short order, we will then have a 25-year deficit, a hole that much deeper from which to climb. We also will suffer the inevitable consequences of compromise productivity, reduced technology, and economic competitiveness and diminished security.

Alternatively, we can begin to reverse the decline of our research base by changing our course now. We can redefine the Federal role in research to include leadership responsibility for both long-term investment and research and investment in the laboratories that house National Academic Science and Engineering Programs. We must make the difficult choices to accommodate both of these elements as essential, individual components of a balanced and effective national investment strategy for research.

H.R. 2823 states in clear terms the policy choices before us. It invites debate of the right questions. We are pleased to support it. We commend again the author and Members of the Congress who support the legislation. We request your consideration of the improvements that we have suggested. Most importantly for the organizations that I represent here today, we pledge our continuing cooperation in working together to bring the effort to a successful conclusion.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Marshall Criser follows:]

STATEMENT

ON

H.R. 2823
THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985

BY

DR. MARSHALL CRISER

PRESIDENT

UNIVERSITY OF FLORIDA

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

IN BEHALF OF THE

ASSOCIATION OF AMERICAN UNIVERSITIES
AMERICAN COUNCIL ON EDUCATION
NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND
LAND-GRANT COLLEGES
ASSOCIATION OF GRADUATE SCHOOLS
COUNCIL OF GRADUATE SCHOOLS IN THE UNITED STATES

OCTOBER 30, 1985

Introduction

Mr. Chairman and members of the Committee, my name is Marshall Criser and I am President of the University of Florida. As a Floridian and as President of a major research university I am doubly pleased to appear before you today on behalf of the nation's research institutions to endorse a most important initiative by Chairman Don Fuqua. H.R. 2823, "The University Research Facilities Revitalization Act of 1985."

My comments are being offered on behalf of five major higher education associations: the Association of American Universities, the National Association of State Universities and Land-Grant Colleges, the American Council on Education, the Association of Graduate Schools and the Council of Graduate Schools in the United States. As the Committee knows well from working with these associations over the years, the universities and research-oriented colleges that are their members perform more than half of the total basic research supported by the National Institutes of Health, the National Science Foundation, and the four major mission agencies: NASA and the Departments of Defense, Energy and Agriculture.

Mr. Chairman, I must begin these remarks by congratulating you, on behalf of the nation's universities, for introducing H.R. 2823. As others appearing here before me already have said, at long last we have a bill on the desks of the Members of Congress that commands the serious attention of all who are concerned about, and who share some responsibility for addressing, the serious problems posed for the nation by the mounting capital deficit of our research and graduate institutions. We applaud your initiative and your leadership. We wish to express to you, and to the more than 50 of your House colleagues who have thus far joined you in this commendable effort, our support and commitment to work together with you to fashion through H.R. 2823 a balanced and sustainable national reinvestment policy for research facilities.

The Problem

Before turning to the specifics of the bill I will place our comments on it in the context of recent funding trends for research and research facilities. A considerable body of evidence documenting the problems posed by obsolete research laboratories and equipment has been presented to this Committee and others in hearings held over the past several years. On May 22 of this year, for example, Dr. Donald Langenberg, Chancellor of the University of Illinois at Chicago, testified on behalf of the associations I represent today before the Committee's Task Force on Science Policy. In his statement Dr. Langenberg ably reviewed the historical role played by federal agencies during the 1950s and 1960s. He also summarized the results of several recent assessments of our present needs to modernize the capital base of our research and graduate enterprise. Since our time this afternoon is limited I will not repeat all of the points made by Dr. Langenberg, but I do support his statement and commend it to your attention.

As the Subcommittee considers the case for a systematic national reinvestment strategy in our capital base for research the following sobering trends provide helpful context:

1. During the period 1953-1967 the nation increased its investment in academic research and development by an average rate. in constant dollars. of 15.7 percent per year; during 1968 to 1983 our investment grew at a rate of only 1.6 percent per year. As our rate of investment declined our enrollments in key fields such as engineering. computer science and bioscience were expanding to all time highs, and new research fields were opening fresh opportunities and placing greater demands on the system. The requirements imposed upon our research and education programs outpaced our investment in the institutions themselves. Neglect and sustained stress has been the predictable and inevitable result of our reduced investment.

2. In the late 1950s and 1960s we responded to the challenge of Sputnik by investing in basic science and engineering research programs. including research facilities. But we failed to sustain our commitment. By the mid-1960s investments began to lag. During the

seventeen year period from 1966 to 1983 our total spending on academic R&D facilities and equipment has remained relatively flat. Despite this our universities and colleges tried vigorously and creatively to sustain their institutional reinvestment programs.

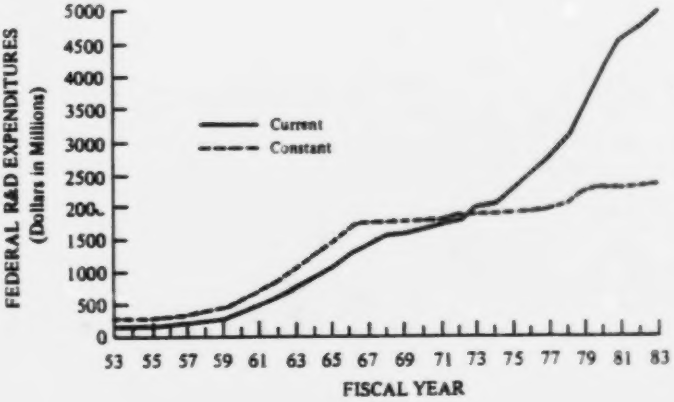
Current spending now totals about $1 billion per year. That is a substantial sum in absolute terms, but consider this fact. The investment rate represented by that constant level of investment has remained essentially flat in current dollars since 1966 -- almost twenty years! **This means that since 1966 our level of effort has declined in real terms by 78%.** Clearly, despite their best efforts, research universities are unable to meet the nation's facilities needs alone. Institutions now face substantial backlogs of deferred laboratory modernization. The renovation of existing space alone may account for more than one half of the total needs. Replacement construction and new construction to respond to new research opportunities account for the balance.

3. The Federal effort has virtually disappeared. In the mid-1960s direct Federal investments in academic research facilities and equipment accounted for about 1/3 of the total national effort. By 1983 federal funds accounted for only 12 percent in current dollars.

> Since 1973 Federal obligations for academic R&D plant have been flat at about $38 million per year. In real, or constant dollar, terms federal investment in academic research facilities fell 93 percent between 1966 and 1983! Is it any wonder that most research institutions view the research agencies that manage our federal fundamental research enterprise as narrowed in their mission and investment responsibilities? In a real sense federal research agencies have "gone out of business" in the facilities area. Often they focus their research programs on near-term, procurement-oriented modes of research support in the service of narrow and often changing mission requirements. The following three figures from a recent report by three associations show these disturbing funding trends.

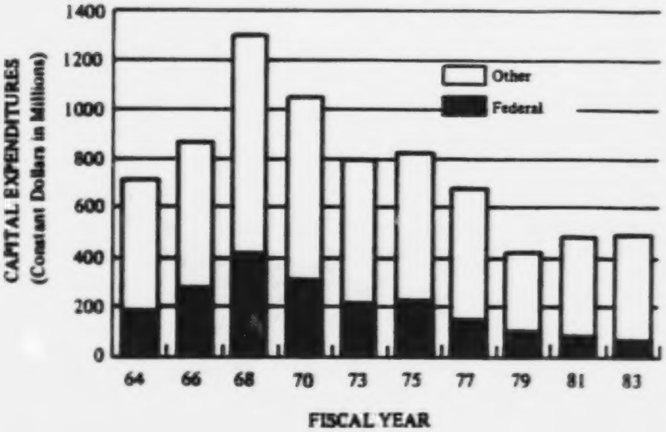
Until quite recently Federal research agencies paid relatively little attention to the consequences of the growing capital deficit. either for their capacities to pursue their own missions and programs or for our longer-term national objectives. Several agencies have begun or expanded small programs to invest in university research equipment. NSF, for example, now allocates about 20 percent of its research funds to equipment. This is more than double its level of effort of just a few years ago. Smaller initiatives of DOD NIH. and DOE have been warmly welcomed by investigators and institutions alike, but these programs generally have been overwhelmed by the accumulated

FIGURE 1
Federal R&D Expenditures at Universities and Colleges
Fiscal Years 1953-1983



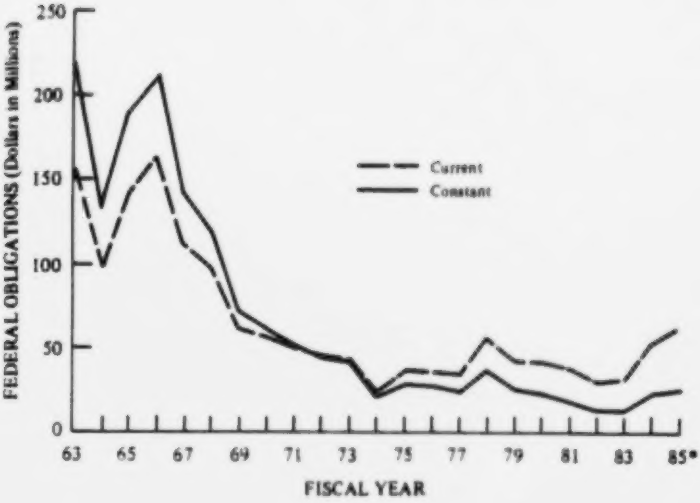
Source: Financing and Managing University Research Equipment. AAU/NASULGC/COGR, Washington, D.C., 1985.

FIGURE 3
Capital Expenditures for Academic Scientific and Engineering Facilities and Equipment for Research, Development, and Instruction
Fiscal Years 1964-1983



Source: Financing and Managing University Research Equipment. AAU/NASULGC/COGR, Washington, D.C., 1985.

FIGURE 4
Federal Obligations for R&D Plant to
Universities and Colleges
Fiscal Years 1963-1985



Source: Financing and Managing University Research Equipment. AAU/NASULGC/COGR, Washington, D.C., 1985.

capital needs of investigators.

We are pleased to note that the Director of the National Science Foundation is taking several steps to have NSF address more directly the need for research facilities. On September 27 Mr. Bloch issued Important Notice No. 98, in which he announced that NSF will now accept proposals for research facilities funding. The announcement stressed, however, that the Foundation has no additional funds with which to respond to the proposals it now invites. The announcement, and Mr. Bloch's testimony last week before this Subcommittee, clearly indicate that because the Foundation's resources are constrained successful facilities projects will be limited to funding only "specialized facilities"; i.e., those deemed essential to the scientific progress in particular fields.

We fully support and welcome Mr. Bloch's initiatives. These actions are significant. However, they must be considered only first steps toward a comprehensive NSF facilities reinvestment program. Considered alone, the present efforts of the Foundation fall short of bringing it into the full leadership position proposed for it by H.R. 2823.

The Department of Defense also has undertaken important initiatives to assist in the modernization of university research facilities. These were briefly described for you by witnesses for the Department last week. A recent DOD analysis of the needs is particularly pertinent to the proposals of H.R. 2823.

In April, at the direction of the House Committee on Armed Services, the Department completed a survey of the priority research facilities needs of approximately 20 key universities in just five fields essential to national security programs: **chemistry, electronics, engineering, materials and physics.** In designing the survey the Department chose not to survey universities. Instead, the project asked the research program officers of each of the services (Army, Navy, Air Force and the Defense Advanced Research Projects Agency - DARPA) to estimate the most pressing capital requirements of the university laboratories in which their own agency's research programs are being conducted. The research program officers of the Services responded by estimating that in just these five fields **20 key universities require immediate facilities investments totaling about $700 million.** The report **recommends** that the Department of Defense establish a **five-year, $300 million laboratory modernization program, and that other federal agencies join DOD in a government-wide effort.** I understand that copies of the DOD report have been made available to the Committee.

We also are pleased that the Department is proposing a small new program - the $25 million University Research Initiative (URI) - to strengthen investment by the Services in universities. DOD is proposing small graduate fellowship programs to encourage promising students to pursue doctoral training, expanded research opportunities for talented young faculty, greater interchange between investigators in university and DOD laboratories and expanded investments in research equipment. At the moment, however, the implementation plans for the URI do not include a laboratory modernization program element. The recommendations of the Department's April report, we believe, generally are consistent with the concepts and approach proposed for DOD by H.R. 2823.

In his testimony to the Task Force on Science Policy Dr. Langenberg reported the findings of an audit of all university buildings conducted by the University of Illinois. Fifty-six percent of the buildings on the Urbana campus and 44 percent of the total on both the Urbana and Chicago campuses of the university are over 50 years old. The total cost to renovate the better buildings and to replace the worst is estimated at just under $600 million; a substantial share of the space is in research facilities. It is important to note that this estimate omits needs associated with adaptations required for new kinds of research. I believe that it ought to disturb us deeply to know that this is a typical situation for many of our research universities and colleges.

The circumstances of the University of Florida certainly affirm this. When we include the Health Center complex, the University's Institute of Food and Agricultural Sciences research and training programs, and the core unit of the University of

Florida, its Education and General budget, our needs (major renovation of six very old buildings and standard deferred maintenance costs) are estimated at $110 million.

Comments on H.R. 2823

With that as background I will turn now to the specifics of H.R. 2823. Just last week the membership of the Association of American Universities considered H.R. 2823. We discussed the bill at considerable length. Both support for the bill and concerns about its impact were expressed by the members. The outcome of our deliberations, I am pleased to report, was a unanimous endorsement of the bill, in principle, and of some specific proposals for improvements in it. The members asked that I convey to Chairman Fuqua and this committee their appreciation and support. H.R. 2823 is a worthy beginning, and, as such, merits the careful attention and support of the entire research community.

As deliberations on the bill proceed we urge sustained support for the objectives and government-wide approach embodied in the statement of findings of H.R. 2823. The importance to our national welfare of reinvestment in our research enterprise cannot be overestimated. As the bill acknowledges national research policy must be redefined to recognize that investment in research must include investment in the capital base essential to national research objectives. A truly national effort, involving federal agencies, state governments, universities, industry and others must be undertaken and sustained. To succeed that effort must be led by direct agency investments along the lines proposed by H.R. 2823. The capital deficit is not an immediate problem in search of a one-time solution. The present situation has been building for almost twenty years; even if we were to muster the political will to act decisively today, we lack the structures, processes and resources to fully address the problem in a single stroke. The capital problem is a complex, long-term one; it is a chronic problem in search of a long-term reinvestment remedy.

We are pleased that the bill recognizes the scale and complexity of the situation by providing for an initial ten-year program. It doing so it seeks to restore in each of the major six agencies the historic and necessary linkages between Federal investment in research and training with investment in the capital base. The bill recognizes the inseparability of research and research capital. The facilities modernization programs thus will be targeted appropriately on disciplines critical to each agency's mission.

We particularly commend the bill's requirement that all facilities modernization awards be made on a competitive process according to the three criteria specified in Sec 3 (b). The nation will derive the greatest return on its facilities investments if the appropriate legislative steps are taken to ensure that all awards are made following well-established, merit-based, competitive processes. We urge the Committee to further strengthen this feature of the bill, and to make it the dominant criteria for the award of funds in each agency's facilities modernization program the quality of the research and training to be carried out in the facilities involved. We ask the Subcommittee to ensure that each agency gives greatest weight and first consideration to the scientific and technical merit of the research and related training programs to be carried out in the proposed facilities.

There is another related reason why this initiative is timely. When institutions perceive that the Executive branch agencies have effectively "gone out of business" in the area of facilities some feel forced to turn to the Congress for relief. As this Committee knows well, in recent years a proliferation of ad hoc legislative initiatives has resulted. Essentially all institutions, including many of those who have resorted to direct appeals to the Congress. will prefer to compete with others for research agency facilities support, provided the competition is an open and fair one. The bill provides a welcome opportunity to minimize pressures for ad hoc solutions unrelated to our larger long-term research priorities and needs. This is an important additional reason we support the intent of the bill.

Title I of the bill authorizes the National Science Foundation to "design, establish, and maintain a data collection and analysis capability...for the purpose of identifying and assessing the research facilities needs of universities and colleges". Sound agency management of laboratory modernization programs will require a strong information base concerning the condition of our present facilities inventory and on the needs of disciplines and institutions. We are encouraged that the House and the Senate already have adopted this provision as part of the FY 1986 NSF Authorization and that the Foundation is moving ahead to implement the assessment program. We ask the Committee to encourage prompt implementation of the data collection and assessment system.

Recommendations

The AAU membership asked me to convey to the Chairman and to the Subcommittee two particular concerns and to respectfully ask that two modifications be made in the bill. These changes, we believe, respond to the concerns we have identified. They also respond to the most serious concerns with the bill identified by the institutions and associations I represent today.

1. Strengthen the funding mechanism in all titles of the bill so as to protect better the research programs of each agency in the event that the newly authorized funds ($470 million) are not fully appropriated and provide for a structured (perhaps three-year) implementation of the ten percent

funding requirement of the bill.

This recommendation reflects a primary reservation among many of our institutions that, under certain circumstances, the bill will require facilities programs to be funded entirely at the expense of ongoing research programs. It is not the intent of the bill, as we understand it, to force the cost of the new modernization programs to be borne exclusively by the research programs of each agency. Rather we believe that the bill seeks to lay a foundation of new funds in FY 1987 and, carrying that foundation forward into future years, to build facilities modernization programs as part of each agency's research activities. To fail to protect the research base more fully over the life of the bill will place an added burden on already strained agency research programs, diminish essential support for new facilities initiatives and further exacerbate the present stresses within the research system.

Therefore we urge the Subcommittee to further strengthen this provision of the bill by requiring that the funds proposed for FY 1987 be fully authorized and appropriated in FY 1987 and in each succeeding year before the full ten percent funding requirement can take effect, and to phase in over a three-year period the full ten percent reserve for facilities.

2. Retain the matching requirement and modify the present 50/50 requirement to "at least 25 percent but not more than 50

percent."

This will respond to the second concern of research institutions of all kinds - large, small, public and independent. Agencies and institutions should have greater flexibility in negotiating matching requirements appropriate to the circumstances of individual institutions. Such flexibility will allow agencies to leverage federal funds effectively while being more sensitive to the financial circumstances of individual institutions. Finally, we recommend that the bill explicitly recognize the need for equipment in a modern facility by including fixed and movable equipment within the total project cost for purposes of determining the matching requirement, thus allowing institutions to meet matching requirements by contributing fixed or moveable equipment to the funded facility.

Is A New Law Needed?

Some of those familiar with H.R. 2823 believe that new law is unnecessary. They argue that the six research agencies already possess sufficient statutory authority to propose facilities programs, if they wish to do so. This may be so in part, for agencies such as the National Science Foundation and the National Institutes of Health. We see little evidence, however, that either they or the major mission agencies will, in fact, establish the required policies and create facilities programs in the absence of a fresh expression of Congressional direction and support.

For almost twenty years it has been national policy to leave to the research agencies discretion to identify priorities and target funds in the light of available resources, needs and opportunities. For more than a decade the equipment problem grew steadily as competing priorities pushed equipment and facilities needs to the bottom of each agency's priority list. In a time of constrained budgets the natural tendencies of investigators, their program managers and senior agency and university officials is the same; i.e., defer this year's capital needs in the hope that next year things will be better. This coping strategy has not served us well. Denial and delay can no longer form the basis for national research policy. We must begin to make the necessary and difficult policy choices and to equip our instruments of national policy. the federal research agencies with the necessary policies and resources to do the job.

A Reinvestment Strategy. Not A Quick Fix. is the Proper Goal

The capital deficit is not a single problem in search of a one-time quick-fix solution. It is. rather. a challenge to our ability to articulate, to implement and to sustain a set of policies designed to reinvigorate investment in our research base. It is a challenge that must be met if we are to sustain our leadership in science and technology. H.R. 2823 is one essential ingredient, but only one, of such a reinvestment policy. Intertwined with the direct investments called for by H.R. 2823 are three related initiatives. We urge the Committee to lend its support to attaining the following related policy objectives:

1. Tax Incentives for the Donation of Research Equipment Should Be Retained and Strengthened to Include Instructional Equipment, and the Related Operation and Maintenance of Donated Equipment.

   The research equipment donation provision of the Economic Recovery Tax Act of 1981 is demonstrating impressive effectiveness as an incentive for the donation of research equipment by manufacturers. The provision should be made permanent and recognized as an important part of national research policy. It also should be modified to include operation and maintenance agreements for donated equipment and the donation of instructional equipment. This will provide comparable incentives to manufacturers of instructional equipment to assist in the modernization of undergraduate instructional laboratories.

2. Authority to Finance University Facilities Through Tax Exempt Bonds Should be Retained.

   An important element in the facilities financing strategies of institutions, both public and private, is the ability to participate in the tax exempt financial marketplace. If independent universities have their ability to participate in the tax exempt bond market restricted then even the current constrained level of institutionally financed facilities modernization will be seriously jeopardized. This indeed will be a large step backwards. We therefore ask for the Committee's support with the Committee on Ways and Means to retain this essential avenue to the financing of academic facilities.

3. Modernize the Depreciation and Use Allowance Provisions of the Federal Cost Recovery Rules.

OMB Circular A-21 establishes the rules for the recovery of indirect costs on federally financed research projects. Present provisions allow institutions to depreciate privately financed facilities that house federally funded research programs on a 50-year basis. Present commercial practice suggests that a depreciation period of between 15 and 20 years more accurately reflects the requirements of modern research. The use allowance for equipment financed by the university is now predicated on a useful life of about 16 years. Most modern equipment now has a useful life of between five and seven years, some even less. We ask that the Committee indicate its support to the appropriate OMB and agency officials for the modernization of these provisions of OMB Circular A-21.

As we pursue these necessary changes in Circular A-21 it will be important that members of the Congress, the Executive agencies, investigators and institutions alike recognize their inevitable result. Indirect costs will increase when we adjust the depreciation and use allowance provisions. Since OMB Circular A-21 properly recognizes facilities costs as legitimate costs of doing research, bringing the facilities provisions of the costing rules into the modern era will increase the costs associated with the facilities components of total indirect costs. Because considerable misunderstanding surrounds the issue of indirect costs we believe it is essential to make this point in the clearest possible terms. With that clear understanding, and with your support, we must pursue the overdue modifications in OMB Circular A-21.

Conclusion

In conclusion, Mr. Chairman, as we face the prospects of unrelenting pressure on our research budgets we have a difficult, but unavoidable policy choice before us. On the one hand we can chose to allow the research capital deficit to worsen at its current pace. In short order we then will have a 25-year deficit, a hole that much deeper from which to climb. We also will suffer the inevitable consequences of compromised productivity, reduced technological and economic competitiveness and diminished security.

Alternatively, we can begin to reverse the decline in our research base by changing our course now. We can redefine the federal role in research to include leadership responsibility for both long-term investment in research and investment in the laboratories that house national academic science and engineering programs. We must make the difficult choices to accommodate both of these elements as essential, indivisible components of a balanced and effective national investment strategy for research.

H.R. 2823 states in clear terms the policy choices before us. It invites debate of the right questions. We are pleased to support it and to commend to you the above improvements. We pledge our continuing cooperation in working together to bring the effort to a successful conclusion.

Thank you Mr. Chairman. I will be pleased to respond to questions.

Mr. **Walgren**. Thank you very much. We appreciate that presentation.

Let's turn to Dr. Melnick then.

Dr. **Miller**. Mr. Chairman, I, too, will be brief, because I did submit a longer——

Mr. **Walgren**. I'm sorry. I wasn't clear enough. Dr. Melnick, and then we'll go to Dr. Miller.

Dr. **Miller**. OK. Thank you.

Mr. **Walgren**. I'm sorry. I jumped around on the list that we have and went from right to—from left to right across—rather than up and down. We usually go the other way. This time I'm afraid I've got Dr. Melnick really ready to go now.

Dr. **Melnick**. Thank you, Mr. Chairman and members of the subcommittee.

It is indeed a privilege to appear before you to offer testimony in support of H.R. 2823. I will dispense with the introduction to abide by the time limit.

I represent here the NAFEO institutions which consist of public and private, graduate and professional, 2- and 4-year institutions of higher learning. These are spread across the United States, including the Southern, Northeastern, Midwestern, and Western States, the District of Columbia, and the Virgin Islands. Jointly they have produced 70 percent of all black undergraduate degree holders to date. The future projection is that they are expected to produce approximately 30,000 graduates per year. Seventy-five percent of all black Ph.D.'s in this country and 85 percent of all black physicians, for example, are graduates of these institutions.

Therefore, Mr. Chairman, undoubtedly these institutions have a long and continuing record of educating and training many of the Nation's leaders and professionals.

Mr. Chairman, we would like to commend Chairman Fuqua for introducing H.R. 2823, the University Research Facilities Revitalization Act of 1985. He warned that:

> If as a nation we do not commit ourselves to maintaining the best possible facilities, we will not only minimize our present scientific potential but we will also mortgage our future possibilities as well.

Indeed, we as a nation must heed that warning for what is at stake is our Nation's established preeminence in scientific and technological research which has been a most significant factor in preservng our national security and the health and well-being of our citizens.

Therefore, it is with the greatest sense of admiration, for this most timely initiative represented in H.R. 2823, that we endorse and support what it intends to achieve.

We offer the following recommendations in a spirit of cooperation and with the understanding that it serves to make the sense of the bill, H.R. 2823, cogent, comprehensive, and compassionate. We are certain that with the public service record that Chairman Fuqua holds that is his intent as well, and the intent of this committee.

It is true that during the postsputnik period of the sixties—what is now nostalgically referred to as the "golden age" for scientific research in this country—many universities and colleges received considerable sums of money from the Federal Government to establish and strengthen their research capabilities. I myself was trained in one, the University of Wisconsin at Madison. A number of enviable national laboratories which served to stimulate, provoke, and challenge our scientific talent also came into being around this period. I worked in two of them, the Oak Ridge National Laboratory and the Lawrence Livermore Laboratory. Indeed, as a nation, we recognized that we want to be second to none and, given the proper direction and infusion of talent and resources, we will claim our leadership and excellence in the scientific enterprise. In a large way, we did exactly that.

However, Mr. Chairman, lost in the dazzle and the following momentary blindness were a set of colleges and universities that had long served a particular group of our citizens. This group, due to certain historical reasons that we are all aware of, could not easily find acceptance to the large and preeminent universities of this Nation. The reason for the difficulty in entry was not due to a lack of competence, motivation or ambition, nor was it due to an absence of a desire to succeed, be productive, and contribute to this Nation. Put it simply, it was due to a matter of color.

It thus became the responsibility of the NAFEO member colleges and universities to educate and train a large majority of the black citizens of this country. And it was these same institutions that were forgotten during the postsputnik science research dollar boom years. Due to this we note that of the 19 large national research laboratories that are federally funded and supported, none are found in the universities or colleges that we here represent.

If we take the 1983 R&D funds in science and engineering, it amounts to approximately $4 billion for all universities and colleges, and the HBCU's or the black colleges and universities account for $40 million, which amounts to about 1 percent of that total amount.

Therefore, Mr. Chairman, we recommend that in order to correct and remedy the existing imbalance, and recognizing the special potential and needs of the historically black colleges and universities, that section 3, item C, will include the award of funds for new research facilities in addition to the replacement or modernization of existing facilities.

Mr. Chairman, we all recognize that creativity, intelligence, and skills for innovation are not a monopolgy of any segment of the population. These qualities are distributed in all of us in varying degrees. The expression of these qualities is influenced by the opportunities provided, the encouragement given, and the resources available.

The severe underrepresentation of blacks in the science and engineering fields is well documented. For example, of all employed scientists and engineers in 1982, only 2.6 percent were black. If taken at the doctoral level, the percentage drops to 1.3 percent. At the postdoctoral level, blacks represent less than 1 percent of the total number, and 68 percent of that 1 percent is in the life sciences.

Mr. Chairman, there is a national need—indeed, a national responsibility—to extend scientific and technological education and training to bright, young, and talented students of the HBCU's, for they are severely under-represented in the cadre of our scientists and professionals.

The establishment of research facilities in select capable universities that largely serve communities which are thus underrepresented will give these universities the capability of producing high caliber scientists and engineers; allow these institutions to fully participate in the national research enterprise; give them an opportunity to form needed and valuable partnerships with other university, national, and private research centers and laboratories; and serve to enhance the participation of minorities in both the public and private research arena and thus fully contribute to the accumulation of knowledge that will keep this country in the forefront of the advanced nations.

Section 3, item C further notes that the amount awarded to any college or university will be in an amount not exceeding 50 percent of the cost of replacement or modernization, the other 50 percent to be secured by the institution in matching funds. We would like to point out that universities and colleges, such as those that we represent, that do not have a large number of affluent and powerful alumini, often find it extremely hard to raise such matching funds. Therefore, we request that the matching funds required of such institutions be reduced to a smaller and a realistic proportion.

Section 101(b) provides for NSF to carry out periodic assessments of university and college research facility needs and to report on the implementation of the laboratory modernization programs. We request a special note be added with regard to this, that a comprehensive study on the HBCU laboratory and research facilities be included in such a report.

H.R. 2823 is authorizing the six agencies to create a program for laboratory modernization in universities and colleges and gives the agencies some flexibility of administering such program either under a program created under this act, or through activities carried out under the authority of other laws.

The latter approach might possibly bias the awards in favor of those applicants with a long-standing research record and award history. We recommend if an agency wishes to follow that route that it be advised to allow for a separate program specifically addressing the concerns of this act as well.

In conclusion, Mr. Chairman, in the light of the facts presented, and the special status of universities and colleges that serve the underrepresented minorities in the sciences and engineering profession, we request that a special sum of money be set aside for such institutions. Noting that these institutions have not been the recipients of large sums of research dollars in the past, and that they are a national resource striving to meet a crucial national need of redressing the underrepresentation of minorities in the research enterprise, that they be allocated a set-aside of 15 percent of the amounts reserved for the facility programs by the respective agencies.

Thank you, Mr. Chairman. I will be delighted to answer any questions you or the other subcommittee members may have. Thank you.

[The prepared statement of Dr. Vijaya L. Melnick follows:]

TESTIMONY BEFORE

The Subcommittee on Science, Research and Technology
of the
Committee on Science and Technology
U.S. House of Representatives

on
October 30, 1985
by

Dr. Vijaya L. Melnick
Professor of Biology
and Senior Research Scholar
Center for Applied Research and Urban Policy
The University of the District of Columbia
Washington, D.C.

on behalf of

The Science and Technology Advisory Committee
of the
National Association for Equal Opportunity in Higher Education

Mr. Chairman and members of the subcommittee:

It is indeed a priviledge to appear before you to offer testimony in support of H.R. 2823. The University Research Facilities Revitalization Act of 1985. Dr. Frederick Humphries, president of Florida A & M University, who was invited to testify, was unable to come to Washington at this time. Dr. Humphries is the chairman of the Science and Technology Advisory Committee of the National Association for Equal Opportunity in Higher Education (NAFEO). I serve as a member of that Committee and chair its subcommittee on legislative matters. NAFEO currently has 116 institutions on its membership roll. These include public and private, graduate and professional and 2 and 4 year institutions of higher learning. These are spread across the United States including the southern, northeastern, midwestern and western states, the District of Columbia and the Virgin Islands. Jointly they have produced 70% of all black undergraduate degree holders to date. The future projection is that they are expected to produce approximately 30,000 graduates per year. 75% of all black Ph.Ds in this country and 85% of all black physicians, for example, are graduates of these institutions.

Therefore, Mr. Chairman, undoubtedly these institutions have a long and continuing record of educating and training many of this nation's leaders and professionals.

Mr. Chairman, we would like to commend Chairman Fuqua for introducing H.R. 2823 University Research Facilities Revitalization

Act of 1985. His observation that "it has been a long-standing policy in the United States to engage colleges and universities in the nation's research enterprise" is one that we must reiterate and always remember. He went on to say that "these (university laboratories) function as the focus for research that is not only the process by which the individual investigator continues to expand our scientific frontiers, but also as a place where research is conducted as a method of teaching future scientists and engineers." He warned that " (I)f as a nation we do not commit ourselves to maintaining the best possible facilities, we will not only minimize our present scientific potential but we will also mortgage our future possibilities as well." Indeed, we as a nation must heed that warning for what is at stake is our nation's established preminence in scientific and technological research which has been a most significant factor in preserving our national security and the health and well being of citizens.

Therefore, it is with the greatest sense of admiration, for this most timely initiative, represented in H.R. 2823, that we endorse and support what it intends to achieve.

We offer the following recommendations in a spirit of cooperation and with the understanding that it serves to make the sense of the bill H.R. 2823, cogent, comprehensive and compassionate. We are certain that with the public service record that Chairman Fuqua holds that is his intent as well, and the intent of this committee.

1. It is true that during the post Sputnik period of the sixties, what is now nostalgically referred to as the 'golden age' for scientific research in this country, many universities and colleges received considerable sums of money from the federal government, to establish and strengthen their research capabilities. A number of enviable national laboratories which served to stimulate, provoke and challenge our scientific talent also came into being around this period. Indeed, as a nation we recognized that we [redacted] want to be second to none and given the proper direction and infusion of talent and resources we will claim our leadership and excellence in the scientific enterprise. In a large way we did exactly that.

However, Mr. Chairman, lost in the dazzle, and the following momentary blindness, were a set of colleges and universities that had long served a particular group of our citizens. This group due to certain historical reasons that we are all aware of could not easily find acceptance to the large and preeminent universities of this nation. The reason for the difficulty in entry was not due to a lack of competence, motivation or ambition, nor was it due to an absence of a desire to succeed, be productive and contribute to this nation. Put it simply, it was due to a matter of color.

It was therefore the responsibility of NAFEO member colleges and universities to educate and train a large majority of the black citizens of this country. And it was these same institutions that were forgotten during the post Sputnik science research dollar boom years. Due to this we note that of the 19 large national research laboratories that are federally funded and supported none are found in the universities or colleges that we here represent.

Therefore, Mr. Chairman, we recomend that in order to correct and remedy the existing imbalance, and recognizing the special potential and needs of the historically black colleges and universities (HBCU) that Section 3 Item C will include the award of funds for new research facilities, in addition to the replacement or modernization of existing facilities.

2. Mr. Chairman, we all recognize that creativity, intelligence and skills for innovation are not a monopoly of any segment of the population. These qualities are distributed in all of us in various degrees. The expression of these qualities is influenced by the opportunities provided the encouragement given and the resources available. The severe underrepresentation of blacks in the science and engineering fields is well documented. For example, of all employed scientists and engineers in 1982, only 2.6% were black. If taken at the doctoral level the percentage drops to 1.3%. At the post doctoral level, blacks represent less than 1% of the total number and 68% of that 1% is in the life sciences.

Mr. Chairman, there is a national need indeed, a national responsibility to extend scientific and technological education and training to bright, young and talented students of the HBCUs. For they are severely underrepresented in the cadre of our scientists and professionals.

The establishment of research facilities in select capable universities that largely serve communities which are thus underrepresented will give these universities the capability of producing high caliber scientists and engineers; allow these institutions to fully participate in the national research enterprise; give them an opportunity to form needed and valuable partnerships with other university, national and private research centers and laboratories; and serve to enhance the participation of minorities in both the public and private research arena and thus fully contribute to the accumulation of knowledge that will keep this country in the forefront of the advanced nations.

3. Section 3 Item C further notes that the amount awarded to any college or university will be in an amount not exceeding 50% of the cost of replacement or modernization involved, the other 50% to be secured by the institution in matching funds from other non-federal public or private sources. We would like to point out, that universities and colleges, such as those that we represent, that do

not have a large number of affluent and powerful alumni often find it extremely hard to raise such matching funds. Therefore, we request that the matching funds required of such institutions be reduced to a much smaller number:

4. Section 101 (b) provides for NSF to carry out periodic assessments of university and college research facility needs and to report on the implementation of the laboratory modernization programs. We request a special note be added with regard to this. That a comprehensive report on the HBCU laboratory and research facilities be included in such a report.

5. H.R. 2823 in authorizing the six agencies to create a program for laboratory modernization in universities and colleges provides for such agencies to have the flexibility of administering the program created under this Act or through activities carried out under the authority of other laws.

   The latter approach, might possibly bias the awards in favor of those applicants with a long-standing research record and award history. We recommend if an agency wishes to follow that route that it be advised to also allow for a separate program specifically addressing the concerns of this Act as well.

In conclusion, Mr. Chairman, in the light of the facts presented and the special status of universities and colleges that serve the underrepresented minorities in the science and engineering professions, we request that a special sum of money be set aside for such institutions. Noting that these institutions have not been the recipients of large sums of research dollars in the past and that they are a national resource striving to meet a crucial national need of redressing the underrepresentation of minorities in the research enterprise that they be allocated a set aside of 15% of the amounts reserved for the facility programs by the respective agencies.

Thank you again Mr. Chairman and the members of the committee for this opportunity.

Mr. **Walgren**. Thank you very much, Dr. Melnick. I appreciate that.

Dr. Miller.

Dr. **Miller**. Mr. Chairman, I, too, will be brief because I did submit a longer version in writing. I want to congratulate the committee on the importance of bringing this issue before the public and the committee's work in trying to find a proper solution, a proper technique, to handle this very critical problem.

There is no doubt that obsolete research facilities are on the rise, partly because of past practicies in funding those facilities, and partly because the increasingly shorter life time for research equipment and facilities. This problem affects the entire research community, universities and other not-for-profits as well—for example, SRI, Battelle, ITT, Southwest, and other not-for-profit research institutes. These institutes, in aggregate, do about 8 percent of the Nation's basic research.

Why it is important to these not-for-profits I think I can show by example in talking about SRI, and this represents in a way the research of these other institutions. We are a self-supported, not-for-profit organization. We have about 2,800 employees. Of these, about 1,700 have advanced degrees; 500 of them have Ph.D'.s. Our work profile is that about 20 percent of our work is basic research. It is supported by the basic research agencies of the Government and somewhat by the private sector. About 10 percent of our work is commercial work, on the other end of the spectrum, and the remaining 70 percent bridges that gap between applied basic research on the one hand and the commercial work on the other.

We do this kind of work for industry and for Government alike. We need the basic research in order to carry out our mission, of carrying that research across that spectrum through applied research to commercial and Government applications, in bridging the gap, so to speak.

Additionally, we do have an educational role. We have graduate students at SRI. We have about 200 graduate students at any given time, and we have a number of post-docs who are learning how to bridge that gap between academic, basic research, on the one hand, and commercial or Government applications on the other.

I believe I have two suggestions to offer as principles in developing a policy, a practice for remedying this problem. These two principles, in fact, are the same as those that were given in Mr. Bloch's testimony for the National Science Foundation. I support those principles. I suppose I must and I should because I helped develop them as a member of the National Science Board. I won't repeat Dr. Bloch's testimony but I would try to highlight two important aspects of it.

There is a long-term problem and a short-term problem. I think the long-term problem arises because there are some basic structural changes that need to be made to provide a steady effort over an extended period of time rather than only an immediate fix it, quick fix, to the problem. The long-term problem has arisen because of the slow erosion of the practices that did not provide enough support for research equipment and research facilities.

The indirect cost recovery concept was well conceived, but over time it has been eroded. We need to do that right, and I believe that we need to have a fair and sensible use of indirect cost accounting which would enable not-for-profit research organizations, as well as universities, to realistically recover their investment in research facilities.

In principle, the rules allow this, but in practice often the bureaucracy has made it difficult or sometimes prohibitive to really utilize the full capabilities of a policy. The use of realistic and less burdensome depreciation rules applied over a long period of time should provide sufficient reimbursement for maintaining superior facilities and equipment and thereby, over the long term, eliminating this current problem.

The second principle involves the allocation of research funds. Government priorities have generally favored the funding of research projects first, the actual research first, major equipment second, and facilities last, if at all. Now, there is a growing number of fields in which the character of research is changing so as to make it more dependent on specialized facilities. Certain areas of research are becoming much more capital intensive. We believe that the research funding priorities should take into account not only the support of research, the research projects, but also the support of major equipment and facilities as the needs of each of these fields dictate.

This legislation could provide the spark to make those changes, but it must be flexible enough to take into account both the short-term and the long-term problem.

I believe additionally that the bill would be strengthened if the definition of research institutions also included not-for-profit institutions as well as universities. There is precedent in previous legislation. Most legislation, in fact, does include not-for-profits as well as universities. But often the not-for-profit institutions are inadvertently overlooked because they seem to represent a small part of the research community. I would be delighted to discuss this with staff to provide some exact wording which might remedy this problem.

We do, as I said, 8 percent of the Nation's basic research. We believe that this facilities bill will be important to us if it has the form that I have suggested, both a short-term and a long-term solution.

Thank you, Mr. Chairman.

[The prepared statement of Dr. William F. Miller follows:]

Testimony
on
H.R. 2823
The University Research Facilities Revitalization Act of 1985

before the

Subcommittee on Science, Research, and Technology

of the

United States House of Representatives

by

William F. Miller, Ph.D.

President and Chief Executive Officer

SRI International

October 30, 1985

Mr. Chairman, my name is William F. Miller. I am President and Chief Executive Officer of SRI International.

Before beginning my testimony, I should like to laud the initiative of this Committee in addressing an important need of a vital segment of the nation's research community. There is no question that the facilities infrastructure of our research community is in serious need of attention, and the Committee is to be thanked for bringing the problem to national attention. Research at the frontiers of science is seriously impaired when the laboratories and equipment are outdated and inadequate. Unfortunately, obsolete research facilities are on the rise, due in part to practices which have weakened the research community's ability to recover costs and invest in the future. An additional contributing factor is the fact that in many fields the useful lifetime for modern research equipment and facilities is much shorter today than a few years ago. The effectiveness of our research will play a large part in determining whether we, as a nation, can compete. With wisdom ... and wit ... we will not only compete economically, we will define the frontiers.

Facilities infrastructure problems affect the entire research community, which includes the not-for-profit research institutes as well as the universities. While the not-for-profit institutes account for a very small -- less than 2 percent -- part of the overall research and development activities of the United States, their impact over the years has far outweighed their size. Within the not-for-profit research institutes about one-third of the effort is devoted to basic research accounting for almost 8 percent of the national total of basic research performed. The not-for-profit research institutes which perform this work are varied. Their focus ranges from single discipline concentration to those, such as SRI International, whose performance is multidisciplinary.

I will describe more specifically what SRI does as a way of illustrating the contributions of the multidisciplinary institutes. Approximately 20 percent of SRI's work is basic research, performed for government and industry. Another 10 percent is commercialization where we help clients in the final stages of product development. The other 70 percent is applications research across the full spectrum, from science to the marketplace. Approximately 65 percent of our overall work is laboratory-based.

SRI International is a self-supported, not-for-profit research and consulting organization with approximately 2800 employees, of whom about 500 hold Ph.D.'s and 1200 hold Masters degrees. We work entirely on a contract or grant basis with revenues in excess of operating costs invested in advanced equipment and facilities. Our revenues were $193.4 million in

1984 and will be over $210 million this year. About 55 percent of our revenue comes from government agencies, and the majority of that is from mission agencies such as the Departments of Defense, Energy, HHS, and NASA. In addition, we carry out work under grants and contracts with the National Science Foundation and the National Institutes of Health as well. We also perform work under contract for state, local and foreign governments, and domestic and foreign corporations.

Our laboratories are located on a 70-acre site in Menlo Park, California. SRI's property and equipment, valued at cost, is approximately $100 million. We also have offices here in Washington, D.C., in New York and Chicago, as well as in 12 major cities abroad.

While larger than most of the not-for-profit research institutes, we are similar in that we provide a unique and useful bridge between the research and commercial phases of new technologies in many areas. We help move research out of the laboratory into development and into the marketplace. Thus, SRI, Battelle Memorial, IIT Research Institute, Gulf South Research Institute, Midwest Research Institute, the Research Triangle Institute, Southwest Research Institute, and the Southern Research Institute serve as technology transfer agents, synthesizing scientific developments into new applications. But we do more than that, we also assist industry in the setting of technology strategies, forecasting markets, etc. We are unique and important organizations that bridge the gap from basic research to commercial development.

Other organizations do this to some degree, from universities to major corporations. However, to quote Henry B. Hansmann in the Yale Law School Review, "The advantage of a non-profit producer is that the discipline of the market is supplemented by the additional protection given the consumer by another broader 'contract', the organization's legal commitment to devote its entire earnings to the production of services."

With that background, permit me to state my perception of the problem. Underinvestment in research facilities is a problem which has developed over a long period of time. The Committee's efforts to deal with this problem through consideration of H.R. 2823 -- The University Research Facilities Revitalization Act -- are commendable. However, to ensure a long-term solution, I believe that basic structural changes need to be made which would provide a steady effort over an extended period of time rather than an immediate "fix-it" on a large scale. If we do not correct the structural flaws, any immediate fix will be only temporary.

The National Science Board, on which I have the honor to serve, has advanced two basic principles which I believe should govern long-term efforts to combat the facilities problem.

The first involves the fair and sensible use of the indirect cost accounting system which should enable not-for-profit research organizations to realistically recover their investments in research facilities. In principle, the rules would allow a reasonable rate of recovery, but in reality, the governing bureaucracy often makes it almost prohibitive.

The rules, as set forth in OMB Circular A-21,. allow not-for-profit research organizations, including universities, to use either a depreciation schedule or an alternative rule that permits a flat 2 percent of original cost as an annual "use charge." Due to the burden and expense of devising comprehensive depreciation schedules and the often contentious manner of the auditors who apply the rules, many organizations use the alternative 2 percent rule. The result is that research facilities are unrealistically assumed to have a useful life of fifty years.

In contrast, if an organization used, as SRI does, the accelerated cost recovery system, facilities would be judged to have an 18-year life, and equipment a three to 15-year life. Use of realistic and less burdensome depreciation rules applied over a long period of time should provide sufficient reimbursement for maintaining superior facilities and equipment, thereby eliminating the current problem.

This approach would also keep facilities funding within the existing research allocation mechanisms and, therefore, tied closely to the actual performance of research.

The second principle involves the allocation of research funds. Government priorities have generally favored the funding of research projects first, major equipment second, and facilities last, if at all. The priorities are appropriate and do not constrain research in many fields. However, there are a growing number of new fields, such as biotechnology, microelectronics and materials research where the character of research is changing so as to make it much more dependent on specialized facilities.

In essence, research fund allocation priorities should take into account not only the support of research projects, but also the support of major equipment and facilities as the needs of each field dictate.

In the short term, the legislation before this Committee could provide the spark to turn around obsolete facilities. However, it must be flexible enough to provide a proper mix that allows appropriate facilities to be improved without impairing funding for critical research projects.

I would like to offer the Committee, Mr. Chairman, a specific recommendation regarding the definition in the proposed Act. As I have already stated, the problem H.R. 2823 addresses involves the facilities of all not-for-profit research organizations, not just universities. Therefore, I do believe that H.R. 2823 would be strengthened considerably if it included a definition of research institutions which encompassed the not-for-profits. There is precedent in patent law (35 U.S.C. 201(i)) and regulations, as well as previously introduced legislation, to use a definition for "nonprofit organization" which incorporates both universities and not-for-profit research institutions. If these organizations are treated in the same manner after a discovery, it is appropriate that they should be provided with the same initiatives to foster performance of research which leads to discovery.

Congress and mission agencies often unintentionally overlook the not-for-profit research institution in legislation and the promulgation of regulations. To some extent our light has been hidden under a basket. Since we cover the technological spectrum from laboratory to marketplace, we are thought of as similar to a university in one instant and industry the next. In reality, due to financial pressures in recent years, universities have moved closer to the center of the technology spectrum, i.e., the increased performance of applied research and commercialization relative to basic research. At the same time, not-for-profit research institutes have taken on university-type educational responsibilities by providing a unique training ground. We fulfill an important post-doctoral and post-graduate training function through an environment in which young scientists can see the interplay of theory and practice. Additionally, SRI, for example, has a large number of graduate students from nearby universities working at our laboratories. I am forcefully reminded of how effective our training is every time a corporation hires away some of our bright young people.

Despite the similar contributions and functions, not-for-profit research institutions are often excluded from programs unless specifically recognized legislatively.

I would be glad to discuss with your staff specific modifications that could be made in H.R. 2823 which I believe would serve to accommodate the needs of the not-for-profit research institutes.

Mr. Chairman, I appreciate the opportunity to address the Committee on this subject. The research infrastructure of the United States has, over the years, become increasingly obsolete. The initiative which you and your colleagues have taken deserves careful consideration. It has long-term implications for our competitive position in the world and could do much to keep our country at the frontiers of science.

Thank you for your attention.

WILLIAM F. MILLER

William F. Miller, Ph.D. is the President and Chief Executive Officer of SRI International. SRI is an independent, non-profit institution whose activities range from management consulting to scientific research. As president of SRI and an internationally known speaker, Dr. Miller has focused attention on the need for stimulating innovation and revitalizing industry by building on the nation's technological and entrepreneurial strengths.

Dr. Miller was educated as a physicist at Purdue University where he received his Ph.D. in 1956. His career history includes experience in high-energy physics, computer science, university administration and as a business consultant and venture capitalist. He joined Stanford University in 1965 as head of the Computation Group at the Stanford Linear Accelerator Center. In 1970 he was appointed Vice President for Research and in 1971 became Vice President and Provost. He became the first Herbert Hoover Professor of Public and Private Management in Stanford's Graduate School of Business in 1979. He is currently professor of Public and Private Management and of Computer Science at Stanford.

Writer, lecturer, educator, executive, venture capitalist, businessman, investor, management consultant, nature and travel photographer, Dr. Miller is a Fellow of the Institute of Electrical and Electronics Engineers and the American Academy of Arts and Sciences. He was recently appointed as a member of the National Science Board of the National Science Foundation.

Dr. Miller currently serves as a Director of Varian Associates, Pacific Gas and Electric Company, Fireman's Fund Insurance Company, First Interstate Bancorp, and First Interstate Bank of California. He was founding partner of the Mayfield Fund.

Mr. **Walgren**. Thank you very much, Dr. Miller.

Dr. Walker.

Dr. **Walker**. Mr. Chairman and members of the subcommittee, I appreciate the opportunity to present testimony concerning bill H.R. 2832, the Facilities Revitalization Act of 1985.

I represent the Association of Minority Health Professions Schools which consist of the Morehouse School of Medicine, the Tuskegee Institute School of Veterinary Medicine, the Texas Southern University School of Pharmacy, the Meharry Medical and Dental Colleges, Xavier University School of Pharmacy, the Charles Drew Postgraduate Medical School, and the Florida A&M University College of Pharmacy.

With the exception of the health professions schools at Howard University, we represent all of the historically black health professions schools in this Nation. The institutions of our association have graduated 43 percent of the Nation's black physicians and dentists, 50 percent of the Nation's black pharmacists, and 90 percent of the Nation's black veterinarians. We consider these institutions a national resource that produce a special product vital to this country in many ways.

A historical problem that each of our institutions has faced has been the development and maintenance of adequate facilities to nurture an environment conducive to strong academic learning, including research. Many of our schools do not have ultramodern state-of-the-art facilities. Even our new institutions are sorely lacking in new or renovated facilities to expand our teaching, research, and patient care capabilities. To be able to compete with larger, better developed institutions, it is crucial for our schools to continue to expand our research potentials. The development of our institutional infrastructure is critical to our ability to attract bright students, top faculty, and expert researchers.

I am sure, Mr. Chairman, that you have heard of the critical health status disparity that exists in this Nation between blacks and whites. Health and Human Services Secretary Margaret M. Heckler, in the Department's yearly Health USA Report, reaffirmed that black infants are twice as likely to die in their first year as white infants, and that the life expectancy of whites in this Nation is 5 years more than that of blacks. Blacks suffer a greater percentage of hypertension, stroke, heart disease, and some types of cancer than do whites.

The members of our association believe that the aforementioned priorities in facility progress is a key to addressing the health status disparity in this Nation. Closing the gap in health status among whites and blacks should be a top concern on the national agenda. Our institutions should be the units who are performing a considerable amount of this research with reference to training and services to narrow this gap.

Our institutions address other national priority problems as well. For example, researchers at Florida A&M University's College of Pharmacy are working closely with NASA to develop space sickness medications that have minimal effects on the astronauts' ability to peform their duties. They have also worked to find ways to combat jet lag in—they are working to find ways to combat jet lag in space missions and long distance travel for people on Earth.

Like other historical black institutions, for the past decade they have been provided some significant research support from specific institutions and agencies in Washington, but they have never received support for facilities to conduct such research. While we have bright faculty and students desiring to conduct research, our facilities are so cramped that we find it difficult to carry out these important trials.

As you are aware, Mr. Chairman, the state of the art in the health fields changes rapidly. Our historically financially strapped institutions find it increasingly difficult to keep up with the new technology and equipment that is being introduced at an incredibly rapid rate. Additional supports and funds to obtain the state-of-the-art facilities would be a wise—is a wise investment for this Nation.

The bill, H.R. 2823, introduced by Congressman Don Fuqua to revitalize and modernize research and technology facilities throughout this country, is commendable. His and others recognition that the research infrastructure at universities and other facilities throughout the Nation is in need of revitalization and in some cases, such as minority institutions, they are nearly nonexistent, is extremely commendable. This legislation would provide a set-aside of research dollars in several Federal agencies to strengthen the Nation's science and technology base and should assist many institutions and facilities in their quest to develop and modernize their research environment.

At this point, Mr. Chairman, please allow me to comment on a couple of specific provisions of the bill. While there is a definite and pressing need to accomplish the objectives of the bill, the Association of Minority Health Professions Schools becomes alert when this rebuilding program may be accomplished at the expense of excluding critical current biomedical and other technological research being conducted at many of our institutions presented supported by several Federal agencies. I am not concerned how, but we hope this legislation will be enacted with minimum damage to our current research efforts.

Additionally, for the institutions of our association and other historically black colleges, the bill will have a more positive effect if there were a component of the measure that provided for a specific amount of funding or special focus of funds to historical black colleges who have demonstrated research capabilities. We would commend 15—we would recommend 15 percent of the support be allocated to these institutions. This is especially applicable to predominantely black schools because have not heretofore participated in science and technology research on a large scale, thus necessitating an extra boost in order to get involved.

We recommend that provisions be made in this bill for minority institutions very similar to the set-aside of funds recently enacted in the RCMI legislation for the development of research infrastructures at minority institutions, and we are prepared to work with the committee to realize this change.

We are concerned about the matching requirements as indicated by the bill. It would appear that we would need to look at a more realistic percentage for these institutions who will find it difficult to acquire the funds to meet the 50-50 requirement as presently stated. This may, in some instances, prevent certain institutions, and especially minority institutions, from becoming involved.

Again, Mr. Chairman, the Association of Minority Health Professions Schools commend you, Chairman Don Fuqua, for your efforts in addressing this critical national concern. Be assured of our continued participation and commitment to this effort.

Thank you.

[The prepared statement of Dr. Charles A. Walker follows:]

AMHPS

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TESTIMONY OF

CHARLES A. WALKER, PH.D.
DEAN
OF
THE FLORIDA A&M UNIVERSITY
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TALLAHASSEE, FLORIDA

ON BEHALF OF THE

ASSOCIATION OF MINORITY HEALTH PROFESSIONS SCHOOLS

BEFORE THE

HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

CONCERNING

H.R. 2823, THE FACILITIES REVITILIZATION ACT OF 1985

ON

OCTOBER 30, 1985

Mr. Chairman and members of the Subcommittee, I appreciate the opportunity to present testimony concerning H.R. 2823, the Facilities Revitalization Act of 1985.

The Association of Minority Health Professions Schools is comprised of the Morehouse School of Medicine, the Tuskegee Institute School of Veterinary Medicine, the Texas Southern University School of Pharmacy, the Meharry Medical and Dental Colleges, Xavier University School of Pharmacy, the Charles R. Drew Postgraduate Medical School, and the Florida A&M University School of Pharmacy. With the exception of the health professions schools at Howard University, we represent all of the historically black health professions schools in the nation. The institutions of our Association have graduated 43% of the nation's black physicians and dentists, 50% of the nation's black pharmacists, and 90% of the nation's black veterinarians. We consider these institutions a national resource that produce a special product vital to the country in many ways.

A historical problem that each of our institutions has faced has been the development and maintenance of adequate facilities to nurture an environment conducive to strong academic learning including research. Many of our schools do not have ultra modern, state-of-the-art facilities. Even our newer institutions are sorely lacking in new or renovated facilities to expand our teaching, research, and patient care capabilities. To be able to compete with larger, better developed institutions, it is crucial for our schools to continue to expand our research capabilities. The development of our institutional infrastructures is critical to our ability to attract bright students, top faculty and expert researchers.

I am sure, Mr. Chairman, that you have heard of the critical health status disparity that exists in this nation between blacks and whites. Health and Human Services Secretary Margaret M. Heckler, in the Department's yearly Health USA Report reaffirmed that black infants are twice as likely to die in their first year as white infants and that the life expectancy of whites in this nation is 5 years more than that of blacks. Blacks suffer a greater percentage of hypertension, stroke, heart disease and some types of cancer than do whites. The members of our Association believe that the aforementioned priorities in facility progress is a key to addressing the health status disparity in the nation. Closing the gap in health status among whites and blacks should be a top concern on the national agenda. Our institutions should be the units who are performing research, training and services to narrow the gap. Our institutions address other national priority problems as well. For example, researchers at Flordia A&M University College of Pharmacy are working closely with NASA to develop space sickness medications that have minimal effect on the astronauts' ability to perform their duties. They are also working to find ways to combat jet lag in space missions and long distance travel for people on earth. Like other historically black institutions, for the past decade they have been provided significant research support from specific institutions and agencies in Washington, but they have never received support for facilites to conduct such research.

While we have bright faculty and students desiring to conduct research, our facilities are so cramped, we are finding it difficult to carry out these important trials.

As you are aware, Mr. Chairman, the state-of-the-art in the health field changes rapidly. Our historically financially strapped institutions find it increasingly difficult to keep up with the new technology and equipment that is being introduced at an incredibly rapid rate. Additional support and funds to obtain the state-of-the-art in facilities would be a wise investment of this nation.

The bill, H.R. 2823, introduced by Congressman Don Fuqua to revitalize and modernize research and technological facilities throughout the country is commendable. His and others recognition that the research infrastructure at universities and other facilities throughout this nation is in need of revitalization and in some cases such as minority institutions, they are nearly non-existant, is extremely commendable. This legislation would provide a set-aside of research dollars in several federal agencies to strengthen the nation's science and technology base, and should assist many institutions and facilities in their quest to develop or modernize their research environments.

At this point, Mr. Chairman, please allow me to comment on a couple of specific provisions of the bill. While there is a definite and pressing need to accomplish the objectives of the bill, The Association of Minority Health Professions Schools becomes alert when this rebuilding program may be accomplished at the expense of excluding critical current biomedical, and other technological research being conducted at many of our institutions presently supported by several federal agencies. I am not certain how, but we hope this legislation will be enacted with minimum damage to our current research efforts.

Additionally, for the institutions of our Association and other historically black colleges, the bill would have a more positive effect if there were a component of the measure that provided for a specified amount of funding or special focus of funds to historically black colleges who have demonstrated research capabilities . We would recommend 15% of the support allocated for these institutions. This is especially applicable to predominately black schools because most have not heretofore participated in science and technology research on a large scale, thus, necessitating an extra boost in order to get involved. We recommend that provisions be made in this bill for minority institutions very similar to the set-aside of funds recently enacted in the RCMI legislation for the development of research infrastructures at minority institutions and we are prepared to work with the Committee to realize this change. We are concerned about the matching requirements as indicated by the bill. It would appear that we would need to look at more realistic percentages for these institutions who will find it difficult to acquire the funds to meet the 50/50 requirements. This may in some instances prevent minority institutions from becoming involved.

Again, Mr. Chairman, the Association of Minority Health Professions Schools commends you and Chairman Don Fuqua for your efforts to address this critical national concern. Please be assured of our continued participation and commitment to this effort.

I am pleased to respond to any questions you have.

Mr. Walgren. Well, thank you very much for that testimony, Dr. Walker. We certainly appreciate it, and all the testimony.

I see by the clock on the wall that my chairman has come in. Welcome to the committee, Mr. Chairman. We have just heard the first bells there, and I certainly would turn to you for any thoughts or comments you would like to share with us.

Mr. Fuqua. Well, I just want to welcome a couple of very good friends, the president of the University of Florida, Marshall Criser, and also Dr. Walker, dean of the Pharmacy School at FAMU located in Tallahassee.

For many years the University of Florida was in my district, and I kind of still think it is. But I want to welcome you both here. I apologize for not getting here any sooner but we're still trying to resolve the Gramm-Rudman situation and I've got to get back to that. So I just wanted to drop by and say hello and welcome to the committee.

Mr. Walgren. Well, we're just finishing with the first panel. Let me turn to Mr. Boehlert for thoughts. And I want to ask unanimous consent to put his statement, his opening statement, in the record at the beginning, where it should be. I failed to do that at the outset.

Let me recognize Mr. Boehlert.

Mr. Boehlert. Thank you very much, Mr. Chairman.

Mr. Criser, we're getting a lot of requests from a lot of different sources that we have a minority set-aside, that we have eligibility for not-for-profits. On page—I think it is 13 and 14—of your statement, you talk about the need to strengthen the funding mechanism, and I couldn't agree more with you. We would love to do that. Under ideal circumstances, we would be able to authorize and appropriate the funds we need.

As the chairman just mentioned, he's engaged in a little exercise right now that the conclusion of which will force upon the Congress and the administration a program under which reductions are going to be made, and I would like to exempt this category if we could but I don't think that's very realistic.

During Mr. Bloch's testimony from the NSF he pointed out—and this directly relates to your statement—the NSF opposition, because NSF is afraid it's going to take away money from research and put it in facilities. What he really wants, and what I'm hearing from you, and what I really want, too, is not only the money for the research to continue but the additional dollars for the facilities.

But as a practical matter, that's probably not going to come to be, so are we running a risk—and, incidentally, I'm a cosponsor of this bill——

Dr. Criser. Yes, sir.

Mr. Boehlert. Are we running a risk, if we proceed with this legislation for the needed facilities, instrumentation and so forth; are we running a risk of denying adequate resources to our basic research efforts?

Dr. Criser. Well, we understand——

Mr. Boehlert. And furthermore, if I may, is it an acceptable risk?

Dr. Criser. Obviously it is a great concern. Those who believe that if this was just to come out of the money now available for research, that is a threat to everybody, not just to the investigators but certainly to the institutions. We would seek that that not occur.

The fact is, however, that one is not going to do good scientific research in the future if we don't have the necessary facilities to do it in. We have dug a deep hole since the late fifties in this regard. The Federal effort has been reduced from a third of the facility provision to about 12 percent of the facility provision. And it's our feeling that this legislation is a step to put us back on the road of where we need to be.

We realize the current concerns, the Gramm-Rudman thrust and how it will finally be dealt with by the Congress. We realize the jeopardy that that puts all the discretionary research money in. But we believe that with the recommendations we have made, that the language of the bill is such that it will not—that existing research will not carry the full burden of this funding of facilities portion, and that there are some fail-safe provisions written into, in regard to if, for instance, R&D is reduced by as much as 10 percent, then the facilities portion goes to zero. We hope that isn't going to happen. We understand the realities of life, and we think that as much protection is in the present legislation as can be afforded to protect existing research money but keeping in mind that if we don't get facilities updated, the quality of the research is going to suffer greatly.

This also provides the matching incentive, so that the universities can go out to the States and get matching money. We, in Florida, have been reasonably fortunate, considering the growth of our State, in obtaining State matches, and with this kind of incentive from the Federal sector, we believe we can raise, on either the private side or from State appropriations, the matching funds. But when we look at the inventory across the country, as the previous witness who appeared before this committee so well documented, and I didn't repeat today because of the time factor—that was Dr. Langenberg from the University of Illinois—testified before the committee showing what the national deficit is. Just taking one university, fairly typical, I assume, an older university in Florida, the University of Florida, just to renovate and bring up-to-date our laboratory and scientific facilities—not talking about any new building—would be in excess of $110 million.

So we need to understand the problem. We understand the present exigencies of the budget situation. But at least this bill attempts to address that and it has fail-safe provisions in the event that the Congress is forced to go the other way.

Mr. **Boehlert**. I have several more questions of this excellent panel, Mr. Chairman, but we have a key vote on the floor right now and I'm going to have to excuse myself. I would hope the panel would——

Mr. **Walgren**. We'll come back.

Let me recognize Mr. Fuqua, if he would like to question briefly——

Mr. **Fuqua**. No, thank you.

Mr. **Walgren**. If not, we will suspend. And please stay with us because we would like to talk a little bit more with you before we move on to the second panel. So this will take us about 15 minutes or thereabouts.

[Whereupon, the subcommittee was in recess.]

Mr. **Walgren**. Let me call us back to order again.

I had wanted to ask, if I can ask it clearly, the request that the required match be made more flexible than 50-50. Are there suggestions that could give this more flexibility perhaps on a formula basis? One suggestion would be to make it between 25 and 50, and I guess up to the discretion of the agency to pick up. On the other hand, that would seem that you would have a lot of discretion in the agency at that point and they might want to take a 50-50 match over a 25-75 proposal when maybe they shouldn't be if it's just the local match that is the factor.

Our intent here, I think, would be to try to put proposals on equal footing, and if the proper effort is made locally and the proper effort might be different from institution to institution. I'm wondering if there isn't some suggestion that a formula be designed which would qualify a proposal at which point that would remove that factor from the agency's consideration——

Dr. **Criser**. That might be a better result than the proposal that I made in the form of recommendation, Mr. Chairman. The idea was to leave, again to the agency, the ability to leverage these negotiations to compete and to see what kind of proposals came before. But as you say, if there was some way to do this by a formula, that would put everybody on the same footing and maybe therefore be more equitable to more institutions.

The match is, obviously, very, very important, very significant. We're all able to deal with our State legislators or with private donors better when we can say there's a certain amount of Federal money and we need to get it matched. Going to a formula might be preferable to the 25 but not more than 50.

Mr. **Walgren**. Any other thoughts on that matching percentage and how it might best be dealt with?

Dr. **Melnick**. The reason that we have raised that issue, Mr. Chairman, is because of the fact that in many of the Federal supports that we get there is sometimes the matching provision or matching requirement, and that imposes a hardship on universities and colleges such as the ones I represent here, which cannot call upon corporate leaders if they're alumni and so forth. So I think it would be equitable if a formula could be devised which would take into account the financial capabilities of that institution in some way. I don't know how one would go about doing that, but it certainly would make it more equitable than presently.

Mr. **Walgren**. If you took endowment as a rough measure of——

Dr. **Melnick**. Right.

Mr. **Walgren** [continuing]. How strong the alumni are, financially how far up the ladder they've gone. Of course, that could be seen as handicapping people for success. But on the other hand, our problem is one of making sure that everyone has an opportunity to compete for these grants. If you were to do and measure a ratio of endowment to number of students in a given entity within the university or something, and then once you had met that, and that would somehow or other be translated on a sliding scale to asking for less than a match, and then once you met the match, regardless of whether your's was equal to somebody else, the agency would not have the power to decide on that basis.

Dr. **Criser**. Maybe as a threshold that would be a way of qualifying, and then getting a level playing field. I think that probably some of the State institutions across the country probably haven't done a lot of private fund raising over the years and are now getting into the business as opposed to some privates, for instance, that had to do private fund raising for a long period of time.

Mr. **Walgren**. Endowment really only applies to private schools; is that right?

Dr. **Criser**. No, not at all.

Dr. **Melnick**. It applies to all schools.

Dr. **Criser**. All schools, and State universities are now very much in the endowment business, but my point is they've really only gotten in the endowment business in some cases in recent history, as opposed to the privates who have had to be in the endowment business for a long, long time.

Dr. **Walker**. But even though some State schools are in the endowment business, we have many institutions that have no endowments at all. And some of these institutions, it's very important that they become involved in this process and receive funds. So for those institutions the endowment would be at zero if you're using a scale and, of course, their endowments would be at zero and naturally these schools ought to be the ones that would require little, small amounts to match.

Mr. **Walgren**. Once you had the formula up, that might be exactly the effect of it, that the lower the endowment the lower the match that the institution had to proffer to qualify.

Dr. Miller.

Dr. **Miller**. Yes, Mr. Chairman. I have worked on endowments for both public and private institutions. I don't think endowment is a proper measure of the capacity of the institution to raise matching money. There are other opportunities to raise matching money and I think that's what one wants to talk about, the capacity to raise matching money.

Many institutions of high endowment may not have an opportunity to raise money for matching on facilities, and conversely, many institutions with very little endowment have considerable capacity in that due to industrial affiliates programs and the like. But I don't think any single measure like that is going to give a good indication of that capacity.

Mr. **Walgren**. Do you think it's possible to create a measure that you would have confidence in or feel is fair?

Dr. **Miller**. Well, I was trying to think while you were raising the question, because it certainly is an appropriate question. It's hard for me to imagine one at the moment. If I put my mind to it I perhaps could come up with one.

A threshold, even an arbitrary threshold, might in fact be more equitable because of that difficulty I'm mentioning.

Mr. **Walgren**. It's related to the apprehension—it may only be an apprehension—of institutions being locked out of this process for one reason or another.

Dr. **Miller**. Could I return to one of my points, Mr. Chairman?

Mr. **Walgren**. Yes, sir.

Dr. **Miller**. I was making a point about the appropriateness and the viability of the indirect cost recovery mechanism. Indirect cost recovery does, if properly applied and in proper measures—that is, an adequate depreciation—it does return to an institution essentially rent for the facilities that are being used. If that is done, there are quite a number of mechanisms for funding. It's like getting rent for your building. There are various private sector means of funding, from banks, and I know there are a number of considerations now of developing funds which would be, in essence, a guarantee to support that kind of funding, a guarantee of the loans. It does put it back into a private sector means and a broader means of getting funding for buildings if you can, in fact, get proper rents for your building.

So I put a lot of emphasis on getting the indirect cost recovery mechanisms and the applications in equitable and proper form.

Dr. **Criser**. I endorse that statement. In fact, our written statement deals with that point, and we strongly support that the depreciation schedules now allocated through OBI are just unrealistic in the present world.

Dr. **Miller**. A new institution, if it gets that kind of research grant and gets the proper indirect cost recovery, can go to the bank with that. I mean, they're going to get a rent for it and they can get financed.

Now, they may need some support for guarantees because of the irregularity of it—I'm not trying to suggest the system is perfect, but there are a lot of people now considering how to get that backup support to guarantee those loans.

Mr. **Walgren**. We face a situation where we always have to work against what is called the NSF charter, undue concentration, undue focusing of all our research efforts in such a narrow band of institutions that others then just might as well not exist. It almost asks for some kind of affirmative action to spread the distribution at that point.

Dr. **Criser**. Doesn't your 15 percent provision really address that subject?

Mr. **Walgren**. The bill has in it a 15-percent reservation.

Now, it is also true, as I understand it, that that's about the present distribution, that 15 percent of almost any funds we look at now goes to schools that are not at least the largest players in the field. And so the argument goes that that then maintains whatever the current distribution is, but that has left out from participation ranges of institutions, be they minority institutions or small undergraduate institutions that are at least qualified to engage in much of this kind of research.

Dr. **Criser**. But not necessarily left out, Mr. Chairman. I mean, the 15-percent reservation is there. It'll be up to the agencies to determine the allocation of that 15 percent. So it seems to me the bill addresses and it follows the present funding.

I think the other side of that, however, is that what we're looking at here is a natural—pardon me—a national resource to do quality research required by this country and these six agencies. And there needs to be a reservation so that just the rich don't get richer, if you want to put it that way. On the other hand, what we're talking about is where does the Federal Government get the best "bang for its buck"; where can the research be done and be done with the highest quality because we spending Federal funds to see that this research is done on a competitive basis. And you note that the institutions that I represent strongly support the competitive merit system so that the Government gets what it is paying for, and that is assured quality in research.

Mr. **Walgren**. Well, I certainly would be the first to want the quality, but I do have the instinct that our interests are broader than just "bang for the buck," because we're concerned about the breadth of the system and we have minds that have to be reached across the board. We will benefit in the long run from reaching those minds. Admittedly, this is a dilemma and the more you pursue the biggest bang for the buck, the more concentrated you get and the more you sacrifice in terms of minds that might make tremendous contributions had they been given the opportunity.

Let me ask one other thought and then I'll turn back to Mr. Boehlert. As I understand the present agency distribution, the ability of agencies to distribute, there's a very wide variation in how the agencies decide to do whatever it is they do with their research. NSF uses almost an extramural peer review process. The Defense Department apparently uses a merit review that is able to be almost totally overridden by an Assistant Secretary or a political decision in the White House. Lord knows what the Department of Energy uses. There is tremendous variation in the mechanism of the decision.

Now, as I understand the bill, we are expressing our confidence in that decision, without setting out anything other than the most general guideline, that it should be competitive. Do we have confidence in the decisions that are made in these agencies without further guideline to them, or are we running the risk in some of those agencies that relationships that have developed over the years will be very easily retracked and determine the outcome of whatever their decisionmaking process is? Do we have to—should we have some procedure in which we might all be able to agree that we have greater confidence than what is presently distributed in such a variety among the agencies?

Can I ask for any responses on that? Dr. Melnick.

Dr. **Melnick**. Mr. Chairman, before I answer that question I would like to come back to the point that you first raised, which is the equitable distribution of these moneys and possibly involving schools which have not been involved prior to this.

I think it is very heartening to hear of your sensitivity to see that the sense of the Congress is beyond just getting the biggest "bang for the buck." I am glad to hear that. I think it is very important to remember that there were several institutions which had not been endowed with these Federal funds prior to that, so therefore the national laboratory and laboratory facilities are next to nothing in those research institutions. If you take the history, for example, Professor Just in Howard, one of the reasons he wanted to develop a laboratory—could not get the laboratory developed—the agencies wanted him to go more into the medical services part and he had to go to Europe to get his laboratories developed. So I think there has been a prejudice prior to this.

We should recognize that. In order that other universities catch up, at least be given a competitive edge to the existing highly endowed laboratories, it is extremely important that we consider that affirmative action aspect. Because affirmative action does not simply involve personnel. It involves an ability of an institution to give the kind of services, the disciplines that are present in those institutions, the people that they serve, and so it is very, very important that we have that kind of equitable distribution because it is on that strength that our country is built. We cannot have an unequitable society and succeed.

Dr. **Walker**. May I just add——

Mr. **Walgren**. Any other thoughts? Dr. Walker.

Dr. **Walker** [continuing]. To what Dr. Melnick has said.

Our brightest and great minds are not necessarily at the bigger and more prestigous institutions. We have many bright minds and people at some of the institutions that have never had an opportunity to develop. Of course, we are ignoring a tremendous potential for resouces here in terms of the high technology development.

The 15 percent that is mentioned in this bill for small universities should be looked at very carefully, because even we may talk about small universities but certain segments—especially in predominant black minority institutions—could easily be left out of this 15 percent. That's our concern.

Mr. **Walgren**. I see.

Dr. Miller.

Dr. **Miller**. Mr. Chairman, first I would want to support the notion that we do need to broaden the base, and I would just point out that the Science Foundation has quite an aggressive program for broadening the base of support for research. One could argue whether it's enough or not, but they do have quite an aggressive program and I support that. I think it's an essential idea.

On your question as to the confidence in the decisionmaking process, I would say by and large I am quite confident in these decisionmaking processes. They will go awry from time to time. I'm not sure that more rules or bureaucracy would help that because each of the agencies does have a different problem. Sometimes an applicant who is dealing with, say, the National Science Foundation on the one hand and the Department of Defense on the other will see the decision made in a different way and may be puzzled by it. But there are different missions there. I think it's entirely appropriate that this decision process be different where there are different missions. By and large, I am quite confident on it. I think that that's something that needs constant attention. Like any other quality issue, the heads of these agencies need to be constantly focusing their attention on the quality of the decisionmaking.

Mr. **Walgren**. Mr. Boehlert.

Mr. **Boehlert**. Dr. Miller, should all types of nonprofits be eligible, or would you draw a line someplace?

Dr. **Miller**. I—well, there are surely—no, there are some that do not do research. They have——

Mr. **Boehlert**. Assuming just what——

Dr. **Miller**. But I would include—the previous language that is most commonly included discusses not-for-profits and universities as one, and that seems to be adequate. Because the not-for-profits that do do research do apply. I guess my main point is that quite a number of not-for-profits that do basic research are supported on program, so it would seem to me incongruous that they wouldn't be supported on facilities if they're supported on programs. I think those that are supported on programs should be eligible for support on facilities.

Mr. Boehlert. I'm not sure who to address this to—maybe all of you would give some thought to it. But how do we avoid—assuming that everything goes exactly the way that we want and this slides through with the modifications that are being suggested—and I think a good deal of them with considerable merit—assuming it slides through the way we want, how do we avoid finding 15 years from now ourselves in the same place we are right now with respect to the facilities of medical schools. Back in the fifties and sixties there was a crisis and Congress responded, 20-some-odd pieces of legislation to provide the money for the facilities, for the medical schools. Here we are now and they're telling us we're back in a crisis situation.

Does it have to be an ongoing effort or——

Dr. Criser. This country only responds to crisis, Mr. Boehlert.

Mr. Boehlert. We're a crisis-driven institution, as you well know.

Dr. Criser. Wars, Sputnik, something arises that gets bad enough, we then respond to that. That's not the way we would design it, but I think that's the way we have always operated.

Mr. Boehlert. I guess what I'm saying, with respect to the medical colleges, they said they had the crisis in the fifties and so Congress responded and approved a ton of money—not literally, but figuratively. They did what they said they had to do. And then here we are now, they're saying the crisis is still there.

Dr. Criser. We have the same crisis now.

Mr. Boehlert. Yes, Dr. Walker.

Dr. Walker. Revitalization of facilities for research should be an ongoing process, and it's just as important as research dollars themselves. You cannot have strong and good research unless you have constant revitalization and modernization of equipment. Research done can be no better than the equipment and the facilities in which it's being done. It bothered me to feel that people think you can separate the quality of research and research dollars from the facilities. So this should be an ongoing process. It's just as important as the research dollars themselves.

Mr. Boehlert. Before I proceed, Dr. Melnick, I understand, Dr. Miller, you have a plane to catch?

Dr. Miller. Yes, sir.

Mr. Boehlert. I think it's unfair to keep you from that plane, so Mr. Chairman, he wanted to be excused——

Dr. Miller. Thank you for having the opportunity to appear, Mr. Chairman.

Mr. Walgren. We want to express our appreciation to you.

Mr. Boehlert. Dr. Melnick has a comment on that.

Dr. Melnick. Thank you.

The only problem with increasing the base of applicants to this, I thought the bill specifically said the investment would be indexed at the annual level of federally-supported R&D performed at universities and colleges, so therefore, if it is indexed to universities and colleges support, then it is logical that universities and colleges compete for that moneys. But if you're going to broaden the base to other nonprofit insitutions also as applicants, then it should be indexed to that. So therefore you broaden the base of the moneys.

Mr. **Boehlert**. Sure.

Should there be a coordinating Federal agency among the six—NSF, for example—or should they just be independent operators and consult with each other?

Dr. **Criser**. Well, the inventory provision is currently in the legislation to allow the NSF to do the inventory, to find out what the backlog is and what the needs are. I think beyond that, to try to put a super board over these agencies, which—you know, Congress is the super board over these agencies because you appropriate the money. I would think that that would be all that you would need, as long as the NSF does provide the information upon which Congress can make its decisions and appropriations.

Mr. **Boehlert**. Thank you all very much. I have no further questions, Mr. Chairman.

Mr. **Walgren**. Well, on behalf of the committee, we certainly appreciate your contribution to this process.

The second panel we have this afternoon includes Dr. James Wyngaarden, the Director of the National Institutes of Health; Dr. Orville Bentley, the Assistant Secretary for Science and Education with the Department of Agriculture; Samuel Keller, Deputy Associate Administrator of the Office of Space Science and Applications with NASA; and Dr. Trivelpiece, the Director of the Office of Energy Research with the Department of Energy. I understand Dr. Wyngaarden will be joined by Dr. Raub, one of the associate directors there.

Well, thank you very much, gentlemen, for coming. As I said at the outset, written statements will be made part of the record, without objection, and you can feel free to focus and underline points that you would like to emphasize for the record. We appreciate your coming.

Why don't we go through the panel in the order in which I introduced you for the record, and we'll start with Dr. Wyngaarden then.

STATEMENTS OF JAMES B. WYNGAARDEN, M.D., DIRECTOR, NATIONAL INSTITUTES OF HEALTH, DEPARTMENT OF HEALTH AND HUMAN SERVICES, ACCOMPANIED BY WILLIAM F. RAUB, M.D., ASSOCIATE DIRECTOR FOR EXTRAMURAL RESEARCH AND TRAINING; ORVILLE C. BENTLEY, ASSISTANT SECRETARY FOR SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE; SAMUEL W. KELLER, DEPUTY ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE SCIENCE AND APPLICATIONS, NASA; AND ALVIN W. TRIVELPIECE, DIRECTOR, OFFICE OF ENERGY RESEARCH, DEPARTMENT OF ENERGY

Dr. **Wyngaarden**. Thank you very much, Mr. Chairman.

I am pleased to be here today to share with you our views on the bill under discussion on behalf of NIH and the Department of Health and Human Services. As you know, Mr. Chairman, Federal agencies have received many expressions of concern that deteriorating research facilities have become a serious problem for academic scientists and engineers, materially affecting their ability to work competitively at the frontiers of scientific and engineering knowledge.

There is little doubt that investment in the research facilities of our universities has been long deferred and demands attention if we are to preserve our preeminence in science. The proposed bill seeks to mandate this investment and makes many interesting and valuable suggestions as to how to proceed. We certainly concur with the intent of the bill. We do, however, have some reservations about some of the specific mechanisms and I will come to those shortly.

Briefly, Mr. Chairman, let me review a little history of involvement in facilities construction by the NIH. Beginning in 1956, there was a great deal of legislation addressed to the research facility needs of the Nation. The Health Research Facilities Act of 1956 was one such measure. During its 14-year lifespan, $484 million in matching funds was obligated by the National Institutes of Health for research facilities construction.

However, after 1968, no further funds were appropriated for this authority, which subsequently expired with its repeal in 1974. This left a vacuum, only partially filled by construction authorites included as sections of other legislation such as the National Cancer Act of 1971, the National Heart, Blood Vessel, Lung and Blood Act of 1972, and the National Health Services Research, Health Statistics, and Health Care Technology Act of 1978, the latter providing construction authority for the National Eye Institute. So since that time we've had just these limited authorities in the three Institutes for specific construction programs.

Under the National Cancer Act authority, beginning in 1971, and still in effect, some $289 million in matching funds has been obligated for construction through 1985. Since 1968, however, the National Heart, Lung and Blood Institute has obligated only $3.3 million for construction, and the Eye Institute in 1982 and 1983, a total of $8.3 million for construction. All of these obligations were in the form of grants to be matched with a like amount of non-Federal funds. Finally, and not often included in assessments of Federal contributions to universities' facilities needs, the NIH provides an estimated $70 million per year in use allowances and depreciation costs to universities. These amounts are included in indirect cost payments associated with individual grants.

The National Institutes of Health fully realizes and supports the need to assess the requirements of university research facilities before massive resources are committed for construction and renovation. Research universities have different expenses and needs according to their age, location, and areas of disciplinary expertise. The research potential of each institution is dependent on the condition of its research infrastructure. We are keenly aware that today's scientific investigation is next to impossible without state-of-the-art facilities and instrumentation.

The realistic aim of any additional construction authority should be to complement the existing authorities. To ensure that any new or additional program enhances the stability, continuity, and sustained long-term effects of the present programs, additional data are needed. It should also be pointed out that any effort to address the problem of university research facilities should emphasize the partnership between the Federal and local governments, the universities, and the private sector.

There is a consensus that a problem exists with respect to facilities obsolescence. I support the general intent of the proposed legislation to address this problem. However, as indicated, we have serious reservations about the approach, and our specific concerns with the bill are these:

First, the 10 percent set-aside after the initial year for which funding is provided; second, the limitation that such a set-aside would have on the flexibility to administer the overall research program; third, the fact that availability of these funds is limited to universities and colleges; fourth, the overlap of authority provided by the bill with other existing construction authorities; fifth, the costs of administering the program; and sixth, the reporting frequency specified in the bill.

The language of the bill makes no provision for any new funding after the initial year, in fiscal 1987, when start-up funds in the amount of $470 million are authorized to be appropriated, and of this amount, $200 million would be in the DHHS portion. For the outyears, fiscal 1988 through 1996, funding for the program would be incorporated into the research base as part of the agencies' regular annual appropriations. Even though provisions are made for reducing the set-aside should the appropriation be reduced, we have concerns about the effect the set-aside might have on other extramural research programs.

The reservation of funds on a fixed-percentage basis would limit administrative flexibility. Although a fixed allocation is a potentially effective way to monitor effect and compliance, it could, in the long run, be detrimental by denying the agencies' flexibility in determining the amounts to be reserved in any particular period.

The language of the bill limits facilities modernization to universities and colleges. This impacts only a segment, albeit a large and important one, of the not-for-profit institutions that perform research. In 1984, for example, 75 percent of NIH extramural funds went to colleges and universities, but 19 percent went to other nonprofit institutions such as independent hospitals and research institutes, which are major contributors to our Nation's research effort. No provision has been made for the eligibility of these organizations and they are no less wanting with respect to facilities renovation. In fact, our current system of funding through the indirect cost mechanism does not discriminate against these independent research organizations. In my printed testimony there is also some further comment about the overlap of existing construction authorities. I would like to make a couple of final comments about the concern about the additional costs required to administer and carry out the objectives of the program, to conduct reviews, site visits, grants management, and so forth. During a period of continuing budget and manpower constraints, this could prove to be a particularly vexing problem.

Corollary to the above is the frequency of reporting on the implementation and the effect of the bill. Reports are required to be submitted to the Congress every 2 years. Although the National Science Foundation bears the brunt of this responsibility, it would be carried out in conjunction with the other Federal agencies. We would prefer perhaps a 5-year basis or an alternating cycle over several years and institutions.

I would be happy to respond to any questions that you and the committee might have, Mr. Chairman. Thank you very much.

[The prepared statement of James B. Wyngaarden follows:]

FOR RELEASE UPON DELIVERY

STATEMENT BY

JAMES B. WYNGAARDEN, M.D.
DIRECTOR
NATIONAL INSTITUTES OF HEALTH
PUBLIC HEALTH SERVICE
DEPARTMENT OF HEALTH AND HUMAN SERVICES

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH, AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

October 30, 1985

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

I AM PLEASED TO BE HERE TODAY TO SHARE WITH YOU MY VIEWS ON THE STATE OF OUR UNIVERSITY RESEARCH FACILITIES. AN ASSESSMENT OF THE CONDITION OF THESE FACILITIES AND THE EXTENT OF THE NEED FOR THEIR REPLACEMENT AND RENOVATION HAS BEEN THE SUBJECT OF CONSIDERABLE DISCUSSION, AND RECENT STUDIES HAVE RAISED QUESTIONS ABOUT THEIR ADEQUACY. FEDERAL AGENCIES HAVE RECEIVED MANY EXPRESSIONS OF CONCERN THAT DETERIORATING RESEARCH FACILITIES HAVE BECOME A SERIOUS PROBLEM FOR ACADEMIC SCIENTISTS AND ENGINEERS, MATERIALLY AFFECTING THEIR ABILITY TO WORK COMPETITIVELY AT THE FRONTIERS OF SCIENTIFIC AND ENGINEERING KNOWLEDGE. IN APRIL 1984, AN AD HOC INTERAGENCY STEERING COMMITTEE COMPRISING THE DOD, NIH, DOE, USDA, AND NSF OBTAINED 5-YEAR CONSTRUCTION PLANS FROM 25 INSTITUTIONS. ON THE BASIS OF THESE PLANS, THE LEVEL OF POTENTIAL EXPENDITURE WAS ESTIMATED. ALTHOUGH LIMITED IN SCOPE, THE EFFORT PROVIDES US WITH A SENSE OF THE CONSTRUCTION PLANS OF SOME OF OUR UNIVERSITIES.

THERE IS LITTLE DOUBT THAT INVESTMENT IN THE RESEARCH FACILITIES OF OUR UNIVERSITIES HAS BEEN LONG DEFERRED AND DEMANDS ATTENTION IF WE ARE TO PRESERVE OUR PREEMINENCE IN SCIENCE. THE PROPOSED BILL, H.R. 2823, SEEKS TO MANDATE THIS INVESTMENT. WE CONCUR WITH THE INTENT OF THE BILL. WE DO NOT FAVOR THE MECHANISMS WITHIN THIS BILL AND CANNOT SUPPORT IT IN ITS PRESENT FORM.

BEGINNING IN 1956, THERE WAS A GREAT DEAL OF LEGISLATION ADDRESSED TO THE RESEARCH FACILITY NEEDS OF THE NATION. THE HEALTH RESEARCH FACILITIES ACT OF 1956 (P.L. 84-835) WAS ONE SUCH MEASURE. DURING ITS 14-YEAR LIFESPAN, $484 MILLION IN MATCHING FUNDS WAS OBLIGATED BY THE NATIONAL INSTITUTES OF HEALTH FOR RESEARCH FACILITIES CONSTRUCTION. AFTER 1968, NO FURTHER FUNDS WERE APPROPRIATED FOR THIS AUTHORITY, WHICH SUBSEQUENTLY EXPIRED WITH ITS REPEAL IN 1974. THIS LEFT A VACUUM, ONLY PARTIALLY FILLED BY CONSTRUCTION AUTHORITIES CARRIED AS PARTS OF OTHER LEGISLATION, SUCH AS: THE NATIONAL CANCER ACT OF 1971 (P.L. 92-218); THE NATIONAL HEART ACT OF 1948 (P.L. 80-655); THE NATIONAL HEART, BLOOD VESSEL, LUNG, AND BLOOD ACT OF 1972 (P.L. 92-423); AND THE HEALTH SERVICES RESEARCH, HEALTH STATISTICS, AND HEALTH CARE TECHNOLOGY ACT OF 1978 (P.L. 95-623), THE LATTER PROVIDING CONSTRUCTION AUTHORITY FOR THE NATIONAL EYE INSTITUTE.

UNDER THE NATIONAL CANCER ACT AUTHORITY, BEGINNING IN 1971 AND STILL IN EFFECT, SOME $289 MILLION IN MATCHING FUNDS HAS BEEN OBLIGATED FOR CONSTRUCTION THROUGH 1985. SINCE 1968, $3.3 MILLION HAS BEEN OBLIGATED FOR CONSTRUCTION BY THE NATIONAL HEART, LUNG, AND BLOOD INSTITUTE. UNDER A SPECIFIC AUTHORITY PROVIDED FOR THE NATIONAL EYE INSTITUTE FOR "A PROGRAM OF GRANTS FOR PUBLIC AND NONPROFIT PRIVATE VISION RESEARCH FACILITIES" IN FY 1979 AND STILL IN EFFECT, FUNDS WERE OBLIGATED IN FY 1982 IN THE AMOUNT OF $5 MILLION AND IN FY 1985 IN THE AMOUNT OF $3.3 MILLION. ALL OF THESE OBLIGATIONS WERE IN THE FORM OF GRANTS TO BE MATCHED WITH A LIKE AMOUNT OF NON-FEDERAL FUNDS. FINALLY, AND OFTEN NOT INCLUDED IN ASSESSMENTS OF

FEDERAL CONTRIBUTIONS TO UNIVERSITIES' FACILITIES NEEDS, THE NIH PROVIDES AN ESTIMATED $70 MILLION PER YEAR IN USE ALLOWANCES AND DEPRECIATION COSTS TO THE UNIVERSITIES. THESE AMOUNTS ARE INCLUDED IN INDIRECT COST PAYMENTS ASSOCIATED WITH EACH GRANT.

THE NATIONAL INSTITUTES OF HEALTH FULLY REALIZES AND SUPPORTS THE NEED TO ASSESS THE REQUIREMENTS OF UNIVERSITY RESEARCH FACILITIES BEFORE MASSIVE RESOURCES ARE COMMITTED FOR CONSTRUCTION AND RENOVATION. RESEARCH UNIVERSITIES HAVE DIFFERENT EXPENSES AND NEEDS ACCORDING TO THEIR AGE, LOCATION, AND AREAS OF DISCIPLINARY EXPERTISE. THE RESEARCH POTENTIAL OF EACH INSTITUTION IS DEPENDENT ON THE CONDITION OF ITS RESEARCH INFRASTRUCTURE, THAT IS, PEOPLE, EQUIPMENT AND FACILITIES. WE ARE KEENLY AWARE THAT TODAY'S SCIENTIFIC INVESTIGATION IS NEXT TO IMPOSSIBLE WITHOUT STATE-OF-THE-ART FACILITIES AND INSTRUMENTATION.

THE REALISTIC AIM OF ANY ADDITIONAL CONSTRUCTION AUTHORITY SHOULD BE TO COMPLEMENT THE EXISTING AUTHORITIES. TO ENSURE THAT ANY NEW OR ADDITIONAL PROGRAM ENHANCES THE STABILITY, CONTINUITY, AND SUSTAINED LONG-TERM EFFECTS OF THE PRESENT PROGRAMS, ADDITIONAL DATA ARE NEEDED. IT SHOULD ALSO BE POINTED OUT THAT ANY EFFORT TO ADDRESS THE PROBLEM OF UNIVERSITY RESEARCH FACILITIES SHOULD EMPHASIZE THE PARTNERSHIP BETWEEN THE FEDERAL AND LOCAL GOVERNMENTS, THE UNIVERSITIES, AND THE PRIVATE SECTOR.

THERE APPEARS TO BE A GROWING CONSENSUS THAT A PROBLEM EXISTS WITH RESPECT TO FACILITIES OBSOLESCENCE. THUS, WHILE I SUPPORT THE GENERAL INTENT OF THE PROPOSED LEGISLATION, I HAVE SERIOUS RESERVATIONS ABOUT THE APPROACH. OUR SPECIFIC CONCERNS WITH THE BILL ARE THESE: (1) THE 10 PERCENT SET-ASIDE AFTER THE INITIAL YEAR FOR WHICH FUNDING IS PROVIDED; (2) THE LIMITATION THAT SUCH A SET-ASIDE WOULD HAVE ON THE FLEXIBILITY TO ADMINISTER THE OVERALL RESEARCH PROGRAM; (3) THE FACT THAT AVAILABILITY OF THESE FUNDS IS LIMITED TO UNIVERSITIES AND COLLEGES; (4) THE OVERLAP OF AUTHORITY PROVIDED BY THE BILL WITH OTHER EXISTING CONSTRUCTION AUTHORITIES; (5) THE COSTS OF ADMINISTERING THE PROGRAM; AND (6) THE REPORTING FREQUENCY SPECIFIED IN THE BILL.

(1) THE LANGUAGE OF THE BILL MAKES NO PROVISION FOR ANY NEW FUNDING AFTER THE INITIAL YEAR, FY 1987, WHEN "START-UP" FUNDS IN THE AMOUNT OF $470 MILLION (THE DHHS PORTION IS $200 MILLION) ARE AUTHORIZED TO BE APPROPRIATED. FOR THE OUT YEARS, FY 1988 THROUGH FY 1996, FUNDING FOR THE PROGRAM WOULD BE INCORPORATED INTO THE RESEARCH BASE AS PART OF THE AGENCIES' REGULAR ANNUAL APPROPRIATIONS. EVEN THOUGH PROVISIONS ARE MADE FOR REDUCING THE SET-ASIDE SHOULD THE APPROPRIATION BE REDUCED--REDUCING IT TO ZERO SHOULD THE APPROPRIATION BE REDUCED BY 10 PERCENT OR MORE--WE HAVE GRAVE CONCERNS ABOUT THE EFFECT THE SET-ASIDE MIGHT HAVE ON OTHER EXTRAMURAL RESEARCH PROGRAMS.

(2) RESERVATION OF FUNDS ON A FIXED PERCENTAGE BASIS WOULD LIMIT

ADMINISTRATIVE FLEXIBILITY. ALTHOUGH A FIXED ALLOCATION IS A POTENTIALLY EFFECTIVE WAY TO MONITOR EFFECT AND COMPLIANCE, IT COULD, IN THE LONG RUN, BE DETRIMENTAL BY DENYING THE AGENCIES FLEXIBILITY IN DETERMINING THE AMOUNTS TO BE RESERVED IN ANY PARTICULAR PERIOD.

(3) THE LANGUAGE OF THE BILL LIMITS FACILITIES MODERNIZATION TO UNIVERSITIES AND COLLEGES. THIS IMPACTS ONLY A SEGMENT, ALBEIT A LARGE AND IMPORTANT ONE, OF THE NOT-FOR-PROFIT INSTITUTIONS THAT PERFORM RESEARCH. IN 1984, 75 PERCENT OF NIH EXTRAMURAL FUNDS WENT TO COLLEGES AND UNIVERSITIES, BUT 19 PERCENT WENT TO OTHER NONPROFIT INSTITUTIONS, SUCH AS INDEPENDENT HOSPITALS AND RESEARCH INSTITUTES, WHICH ARE MAJOR CONTRIBUTORS TO OUR NATION'S RESEARCH EFFORT. NO PROVISION HAS BEEN MADE FOR THE ELIGIBILITY OF THESE ORGANIZATIONS AND THEY ARE NO LESS WANTING WITH RESPECT TO FACILITIES RENOVATION. IN FACT, OUR CURRENT SYSTEM OF FUNDING THROUGH THE INDIRECT COST MECHANISM DOES NOT DISCRIMINATE AGAINST THESE INDEPENDENT RESEARCH ORGANIZATIONS.

(4) THERE IS CONCERN WITH THE MATTER OF OVERLAP WITH OTHER CONSTRUCTION AUTHORITIES CURRENTLY IN EFFECT. THESE INCLUDE:

(a) THE NATIONAL CANCER ACT OF 1971 (P.L. 92-218), WHICH PROVIDES AUTHORITY FOR THE NCI TO MAKE CONSTRUCTION GRANTS.

(b) THE NATIONAL HEART ACT OF 1948 (PUBLIC LAW 80-655), WHICH AUTHORIZED THE EXPENDITURE OF FUNDS FOR GRANTS FOR THE CONSTRUCTION OF FACILITIES FOR

RESEARCH RELATED TO HEART DISEASES; AND THE NATIONAL HEART, BLOOD VESSEL, LUNG AND BLOOD ACT OF 1972 (PUBLIC LAW 94-423), WHICH AUTHORIZED THE EXPENDITURE OF FUNDS FOR THE CONSTRUCTION OF NATIONAL RESEARCH AND DEMONSTRATION CENTERS FOR HEART, BLOOD VESSEL, LUNG, AND BLOOD DISEASES.

(c) THE HEALTH SERVICES RESEARCH, HEALTH STATISTICS, AND HEALTH CARE TECHNOLOGY ACT OF 1978 (P.L. 95-623), WHICH AMENDED THE PUBLIC HEALTH SERVICE ACT "TO CARRY OUT A PROGRAM OF GRANTS FOR PUBLIC AND NONPROFIT PRIVATE VISION RESEARCH FACILITIES."

(5) THERE IS CONCERN ABOUT THE ADDITIONAL COSTS REQUIRED TO ADMINISTER AND CARRY OUT THE OBJECTIVES OF THE PROGRAM (TO CONDUCT REVIEWS, SITE VISITS, GRANTS MANAGEMENT, ETC.). DURING A PERIOD OF CONTINUING BUDGET AND MANPOWER CONSTRAINTS, THIS COULD PROVE TO BE A PARTICULARLY VEXING PROBLEM.

(6) COROLLARY TO THE THE ABOVE IS THE FREQUENCY OF REPORTING ON THE IMPLEMENTATION AND THE EFFECT OF THE BILL. REPORTS ARE REQUIRED TO BE SUBMITTED TO THE CONGRESS EVERY TWO YEARS. THOUGH THE NATIONAL SCIENCE FOUNDATION BEARS THE BRUNT OF THIS RESPONSIBILITY, IT WOULD BE CARRIED OUT IN CONJUNCTION WITH THE OTHER FEDERAL AGENCIES. IT WOULD BE PREFERABLE THAT THIS BE DONE ON A 5-YEAR BASIS, OR ON AN ALTERNATING CYCLE OVER SEVERAL YEARS AND INSTITUTIONS.

I WOULD BE HAPPY TO RESPOND TO ANY QUESTIONS THE SUBCOMMITTEE MAY HAVE.

Mr. **Walgren**. Thank you, Dr. Wyngaarden.

We go then to Dr. Bentley.

Dr. **Bentley**. Thank you, Mr. Chairman. I am pleased to be here to participate in this panel.

My responsibility as Assistant Secretary in the Department of Agriculture has to do with the coordination of research and extension activities and, in so doing, I have an opportunity to work with land grant universities, especially the historically black colleges and universities that have been a part of the Second Morrill Act of 1890.

The avenue for the Department for this interaction is through two agencies: the Cooperative State Research Service that administers formula agriculture research funds, and the Extension Service that administers formula agriculture Extension Service funds. There is, in the normal course of the administration of these grant funds, a number of joint planning activities and interactions that deal with the subject of the capacities of these institutions to support programs that deal with research and education needs of American farmers and ranchers and other parts of our food and fiber system. It is therefore apparent that we are much concerned with the capacities of these institutions to meet the changing and challenging needs for research and education in the agricultural and food sciences.

As we analyze reports in these institutions and meet with them, it is clear that they are facing serious difficulties in providing the kinds of physical resources needed to maintain their programs at a high level of scientific and technical effectiveness. The increased costs of scientific instrumentation and the need to renovate facilities is placing severe strains on existing budgets, although I must say that there has been a valiant effort on the part of many States to provide new facilities and to assist in the purchase of state-of-the-art scientific instrumentation.

As the committee is well aware, there are numerous studies from the National Science Foundation and others that indicate that there are major shortcomings of university and college based research facilities in the United States, and that the shortage of equipment, and especially state-of-the-art equipment, is difficult to maintain in these university—primarily university laboratories. This is true for agriculture as well. I want to point this out, that it applies to agriculture, to the food industry, to forestry, and, of course, in our definition of agriculture we're talking about the fiber production capacity of this country as well.

It is for this reason, Mr. Chairman, that we are pleased to be a part of the discussions aimed at finding a solution to these kinds of needs and to be sure that we will modernize and improve the research facilities in our U.S. colleges and universities. I must add to that not only the research capacity but the ability to provide education grants, especially at the graduate level.

We have, though, some reservation with certain provisions of the bill, H.R. 2823, and we want to discuss some of them in the course of my statement. This statement is similar to ones that have been made by others that have made presentations. I will not go into them in any detail.

I would rather move now to some comments that are more apropos to agriculture, the Department of Agriculture. We've had a long history of cooperative programs with colleges and universities. This support to universities for agricultural research goes back to the Hatch Act of 1887, an act that is still important today. Funds appropriated under this act can be used for research equipment and facilities, but in recent years they have been generally used for program support. In 1963, the Congress authorized special funding for research facilities at the State Experiment Stations under Public Law 88-74. Modest facilities funding was made available under this authority through 1970.

As with most facilities funding programs in that period, there were no funds made available after 1970. For more flexibility in research facilities funding, the Department of Agriculture is requesting as a part of its 1985 farm bill, now under discussion in the Congress, an amendment to the law that would make it possible to accomplish much of what is proposed in H.R. 2823. The proposed amendment would broaden the base of eligible institutions, authorize Federal grant funds on a matching basis, and give the Secretary of Agriculture flexibility to make funds available to the areas of greatest need and potential. We believe that the opportunities for applying funds to the facilities needs of our universities and colleges in agriculture would be addressed through the provisions of an amended Public Law 88-74. This bill would allow the Secretary to balance the benefits of programs versus facilities at any given time for the greatest payoff to the Nation and with the implication for the research and education programs conducted there.

I would also want to mention a special program funding that's made available—first available in fiscal year 1983—by the Department, which has provided $10 million annually to the historically black land grant universities and Tuskegee Institute for research facilities. It is expected that the program will provide a total of $50 million over 5 years to assist these institutions in developing their research capacity. In this connection, there is not a match requirement for this funding from the institutions, and it is a fund set-aside in addition to funds that are made available for support of research.

I could add more detail but I think that the matter of looking at the facilities and the capacity of institutions to provide up-to-date facilities and to provide state-of-the-art equipment is important to the well-being of our agricultural research and extension education programs, and therefore it is important to the Department to participate with the Congress in any way we can to find answers to these kinds of questions.

We agree with the basic approach that is aimed at strengthening the infrastructure for research in our universities, and concur with the intent of the bill. However, we believe the flexibility in the proposed amendments to Public Law 88-74, or can be referred to as the 1985 farm bill, would better meet the needs in agricultural research. Therefore, we do not favor the passage of 2823.

Mr. Chairman, I will be prepared to answer any questions and appreciate the opportunity to be with you.

[The prepared statement of Orville G. Bentley follows:]

STATEMENT BY

DR. ORVILLE G. BENTLEY
ASSISTANT SECRETARY FOR SCIENCE AND EDUCATION
UNITED STATES DEPARTMENT OF AGRICULTURE

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
U.S. HOUSE OF REPRSENTATIVES

OCTOBER 30, 1985

"THE UNIVERSITY RESEARCH FACILITIES REVITALIZATION ACT OF 1985"

I am Orville G. Bentley, Assistant Secretary for Science and Education of the U.S. Department of Agriculture. A major part of my responsibilities for research and education policy and coordination for the Department involves interaction with the Nation's Land-grant Universities, including the historically black colleges and universities receiving the benefits of the Second Morrill Act of 1890. The avenue for this interaction is through two departmental agencies: the Cooperative State Research Service that administers formula agriculture research funds, and the Extension Service that administers formula agriculture extension funds. There is, in the normal course of administering the grants programs through these two agencies, a great deal of joint planning and interaction concerning the capacities of these institutions to provide services to the American farmers and ranchers, and other components of our food and fiber system. We are much concerned with the capacities of these institutions to meet the changing and challenging needs for research and education in the agricultural and food sciences.

As we analyze reports from these institutions, it is abundantly clear that they are facing serious difficulties in providing the kinds of physical resources needed to maintain their programs at a high level of scientific and technical effectiveness. The increased costs of scientific instrumentation and the need to renovate facilities is placing severe strains on existing budgets, although there has been a valiant effort by many states to provide new buildings and to

ASSIST IN THE PURCHASE OF STATE-OF-THE-ART SCIENTIFIC INSTRUMENTATION. NUMEROUS STUDIES BY THE NATIONAL SCIENCE FOUNDATION AND OTHERS INDICATE THAT ONE OF THE MAJOR SHORTCOMINGS OF UNIVERSITY AND COLLEGE-BASED RESEARCH IN THE UNITED STATES IS THE SHORTAGE OF SCIENTIFIC EQUIPMENT AND THE INABILITY TO MAINTAIN MODERN, UP-TO-DATE LABORATORIES. THIS IS TRUE FOR THOSE INSTITUTIONS THAT CONDUCT RESEARCH IN AGRICULTURE, FOOD, AND FORESTRY, AS WELL. A COMPREHENSIVE STUDY CONDUCTED BY A COMMITTEE APPOINTED BY THE DIVISION OF AGRICULTURE OF THE NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLLEGES (NASULGC) TO DEVELOP A PROGRAM-INITIATIVE IN BIOTECHNOLOGY CONCLUDED THAT ONE OF THE MAJOR NEEDS TO IMPLEMENT THIS PROGRAM WOULD BE A SUBSTANTIAL INVESTMENT IN SPECIALIZED EQUIPMENT AND IN MODERNIZING FACILITIES. THIS INITIATIVE, COMPLETED IN 1984, IDENTIFIED A $70 MILLION PROGRAM, OF WHICH ONE-THIRD WAS FOR THE PURCHASE OF SPECIALIZED EQUIPMENT NEEDED FOR THE KIND OF SOPHISTICATED RESEARCH THAT IS CALLED FOR TO EVALUATE THE POTENTIAL OF NEW DEVELOPMENTS IN BIOTECHNOLOGY FOR THE FOOD AND AGRICULTURAL SYSTEM.

IT IS FOR THESE REASONS, MR. CHAIRMAN, THAT I AM PLEASED TO BE A PART OF THE DISCUSSION AIMED AT EXPLORING MECHANISMS FOR MODERNIZING THE RESEARCH FACILITIES IN U.S. COLLEGES AND UNIVERSITIES. HOWEVER, WE HAVE RESERVATIONS WITH CERTAIN PROVISIONS OF THE BILL UNDER DISCUSSION, H.R. 2823, THAT I WILL WANT TO DISCUSS IN MY STATEMENT TO THE SUBCOMMITTEE.

The concept of a fixed percentage of all extramural research funding being set aside for facilities and equipment would remove opportunity for Federal agencies to make reasoned judgements. It seems highly unlikely that the best investment opportunities for the overall research enterprise would fit an arbitrary division between program and facilities. Moreover, we are still left with the impression that, with time, the facilities provision would compete for funds that would otherwise be available for program.

We have further reservations about the provision for at least 15 percent of the funds to be reserved for facility programs at universities and colleges receiving less than $2 million in Federal R&D support. Some special provision for emerging institutions may be appropriate, but it is unlikely than an arbitrary percentage and threshold funding level will effect the best mix in this regard.

The Department of Agriculture has a long history of cooperative programs with universities and colleges. Support to universities for agricultural research goes back to the Hatch Act of 1887, an Act that is still important today. Funds appropriated under this Act can be used for research equipment and facilities, but in recent years they have been more generally used for program support. In 1963 the Congress authorized special funding for research facilities at the State Agricultural Experiment Stations in Public Law 88-74. Modest facilities funding was made available under this authority through 1970. As with most

FACILITIES FUNDING PROGRAMS OF THAT PERIOD, THERE WERE NO FUNDS MADE AVAILABLE AFTER 1970. FOR MORE FLEXIBILITY IN RESEARCH FACILITIES FUNDING, THE DEPARTMENT OF AGRICULTURE AS A PART OF ITS 1985 FARM BILL HAS PROPOSED AMENDMENTS TO PUBLIC LAW 88-74 THAT WOULD MAKE IT POSSIBLE TO ACCOMPLISH MUCH OF WHAT IS PROPOSED IN H.R. 2823. THE PROPOSED AMENDMENTS WOULD BROADEN THE BASE OF ELIGIBLE INSTITUTIONS, AUTHORIZE FEDERAL GRANT FUNDS ON A MATCHING BASIS, AND GIVE THE SECRETARY OF AGRICULTURE FLEXIBILITY TO MAKE FUNDS AVAILABLE TO THE AREAS OF GREATEST NEED AND POTENTIAL. WE BELIEVE THAT THE OPPORTUNITIES FOR APPLYING FUNDS TO THE FACILITIES NEEDS OF OUR UNIVERSITIES AND COLLEGES IN AGRICULTURE WOULD BE ADDRESSED THROUGH THE PROVISIONS OF AN AMENDED PUBLIC LAW 88-74. THIS BILL WOULD ALLOW THE SECRETARY OF AGRICULTURE TO BALANCE THE BENEFITS OF PROGRAM VERSUS FACILITIES AT ANY GIVEN TIME FOR THE GREATEST PAYOFF TO THE NATION.

THROUGH A SPECIAL PROGRAM FIRST FUNDED IN FISCAL YEAR 1983, THE DEPARTMENT OF AGRICULTURE HAS BEEN PROVIDING $10 MILLION ANNUALLY TO THE HISTORICALLY BLACK LAND-GRANT UNIVERSITIES AND TUSKEGEE INSTITUTE FOR RESEARCH FACILITIES. IT IS EXPECTED THAT THE PROGRAM WILL PROVIDE A TOTAL OF $50 MILLION OVER FIVE YEARS TO ASSIST THESE INSTITUTIONS TO DEVELOP THEIR RESEARCH CAPACITY.

THE UNIVERSITIES AND COLLEGES OF THE UNITED STATES CONTINUE TO BE OF GREAT IMPORTANCE TO AGRICULTURE. THE UNIVERSITIES CARRY OUT MORE THAN 60% OF THE PUBLICLY SUPPORTED AGRICULTURAL RESEARCH. THE STATES THEMSELVES ARE THE BIGGEST CONTRIBUTOR TO THE SUPPORT FOR THIS RESEARCH BUT THE WORK IS ALL CARRIED OUT AS

PART OF A NATIONAL NETWORK FOR RESEARCH IN SUPPORT OF AGRICULTURE. THE STATE AGRICULTURAL EXPERIMENT STATIONS WORK JOINTLY WITH THE DEPARTMENT OF AGRICULTURE AND THE PRIVATE SECTOR IN SETTING THEIR PROGRAM PRIORITIES AND ALLOCATING THEIR RESOURCES. THEY ARE A VERY SIGNIFICANT RESOURCE FOR U.S. AGRICULTURE. THE UNIVERSITY PROGRAMS ARE ALSO THE TRAINING GROUND FOR SCIENTISTS TO WORK IN THE FEDERAL GOVERNMENT AND IN THE PRIVATE SECTOR AS WELL AS IN THE UNIVERSITY SYSTEM. THE HEALTH AND VITALITY OF THE AGRICULTURAL RESEARCH PROGRAMS OF THE U.S. UNIVERSITIES AND COLLEGES ARE CRITICAL TO THE WELL-BEING OF AGRICULTURE. FOR THIS REASON WE ARE PARTICULARLY INTERESTED IN INSURING A HEALTHY INFRASTRUCTURE FOR THOSE PROGRAMS INCLUDING RESEARCH FACILITIES AND EQUIPMENT.

TO HELP US DETERMINE WHERE THE NEEDS AND OPPORTUNITIES ARE GREATEST THE COOPERATIVE STATE RESEARCH SERVICE HAS RECENTLY REQUESTED EACH OF OUR COOPERATING UNIVERSITIES TO PROVIDE US WITH UPDATED INFORMATION ON THEIR FACILITIES PROGRAMS.

IN CONCLUSION, I WANT TO COMMEND THE SUBCOMMITTEE FOR FOCUSING ATTENTION ON THESE IMPORTANT ISSUES. WE AGREE THAT THERE IS NEED FOR STRENGTHENING OF THE INFRASTRUCTURE FOR RESEARCH AT OUR UNIVERSITIES AND COLLEGES AND CONCUR WITH THE INTENT OF THE PROPOSED BILL. HOWEVER, WE BELIEVE THE FLEXIBILITY IN THE PROPOSED AMENDMENTS TO PUBLIC LAW 88-74 WOULD BETTER MEET THE NEEDS OF AGRICULTURAL RESEARCH. THEREFORE, WE DO NOT FAVOR PASSAGE OF H.R. 2823.

MR. CHAIRMAN, THIS CONCLUDES MY PREPARED STATEMENT, I WILL BE HAPPY TO RESPOND TO ANY QUESTIONS THE SUBCOMMITTEE MAY HAVE.

Mr. **Walgren**. Thank you very much.

We'll go then to Mr. Keller.

Mr. **Keller**. Mr. Chairman, I will provide the full statement for the record.

Mr. Chairman and members of the subcommittee, thank you for the opportunity to testify before the Subcommittee on Science, Research and Technology, on the University Research Facilities Revitalization Act of 1985, H.R. 2823.

I am pleased to participate in today's hearings about the condition and future needs of university and college research laboratories and equipment. Much of the success which we have achieved in NASA can be traced to the cooperative, productive relationships we have nurtured over the past 27 years with our research partners in other Federal laboratories, in nonprofit research institutions and industrial organizations, and in the universities. Central to NASA's success has been our ability to independently manage our resources among and within such disparate institutions. For some time now, we have recognized the significant problems of obsolete laboratory equipment within the university community. We also recognize that university research facilities modernization is essential to the accomplishment of NASA's research program. However, we feel strongly that funding processes for laboratory equipment and facilities cannot be separated from current NASA management processes used in selecting and supporting university research projects in general.

The bill under discussion today would establish a special pool of funds to finance the modernization and replacement of equipment and facilities in university and college laboratories through university research laboratory modernization programs.

Although the intent of the proposed legislation is worthy, the bill would place severe restrictions on NASA's flexibility and could negatively impact both the accomplishment of our research mission and NASA's support of research at universities. Presently, it is not clear to NASA that the proposed legislation would achieve its intended objectives.

In fiscal 1984 approximately $220 million went to the support of colleges and universities. Estimates for fiscal year 1985 and fiscal year 1986 are $260 million and $300 million respectively. NASA does not identify a specific line item in the budget for sponsored efforts at universities and colleges, but rather determines overall research programs for a given fiscal year and the amount of funding necessary for each program. The identification and funding of such research programs are made on a mission-need basis and not in terms of the ultimate performers. NASA then determines which aspects of its mission can best be met by in-house capabilities and which are best conducted by universities, industries, nonprofit organizations, or other Government agencies. During fiscal year 1984, $220 million was delegated to colleges and universities, of which approximately 10 percent or $22 million was spent on the development and/or replacement of equipment. In fiscal year 1985 this replacement of equipment is estimated at $25 million, and approximately $30 million is projected for this purpose in fiscal year 1986 based on the President's budget request.

The issue of maintaining first-class laboratory research equipment is an important one, and NASA, in concert with governmental and private organizations, is addressing it. While there is no explicit provision in the budget for updating university laboratories and equipment, one of the important functions of the R&D Program is to support university research groups in a manner that includes provisions for research equipment.

It is significant to note, however, that we support universities not only in the Research and Analysis Program, but also in our flight programs. When we select teams for our flight programs they are, in fact, also funded for calibration and test equipment and data processing equipment. This source of funds allows significant upgrading of laboratory equpment in universities participating in the flight program. To illustrate this, I would like to give an example.

The Upper Atmospheric Research Satellite Program is a major Office of Space Science Applications Flight Program. The principal investigators in this program will each be furnished with a remote analysis computer to conduct their research. Thus, each of several universities—and they include Michigan, Colorado, Southwest Research Institute, Texas, the University of Washington, and Georgia Institute of Technology—will receive a significant computer capability to carry out the research. The capability will remain with the universities after completion of the project.

Another example within the Office of Aeronautics and Space Technology is the building of a unique facility at MIT to obtain useful parametric information about material damping and transiet decay of a specimen while in motion under zero G and in vacuum.

University centers of excellence have been established at six universities to develop expertise and to establish facilities and equipment in emerging fields such as composite and ceramic materials, computer sciences, and artificial intelligence. Grants to these centers average $500,000 per year per school.

In summary, NASA supports many of the principles inherent in the University Research Facilities Revitalization Act of 1985. I think it is clear from my remarks that through NASA-sponsored research, we are currently supporting university modernization in a manner consistent with our mission needs and our budget. However, in a period of national budget constraint, NASA has serious reservations about any approach that would restrict our flexibility to make sound programatic decisions which we feel are in the national best interests of accomplishing our mission. We also believe that a new set-aside program would result, in the long term, in decreased funding to meet our research objectives.

Additionally, a separate approach to alleviating the problem through set-aside programs in numerous agencies would increase the overall institutional costs for administration and control. NASA is acutely aware of the need to modernize university laboratory equipment and facilities and we will continue to focus our efforts on the problem through our traditional university sponsored research. The proposed legislation would not, in NASA's view, improve the current situation. Therefore, we do not support H.R. 2328 in its present form.

Mr. Chairman, that concludes my testimony. I would be happy to respond to any questions the subcommittee may have.

[The prepared statement of Samuel W. Keller follows:]

National Aeronautics and
Space Administration

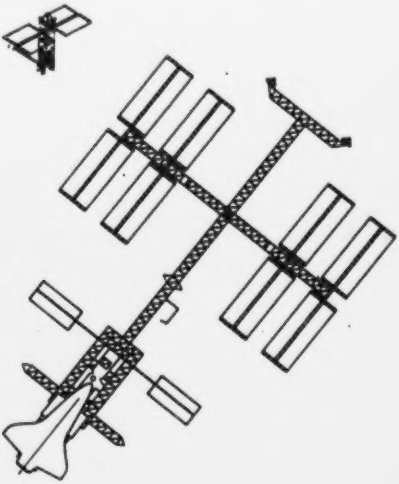
Hold for Release Until
Presented by Witness

October 30, 1985

Subcommittee on Science, Research and Technology

Committee on Science and Technology

House of Representatives



Statement by:

Samuel W. Keller
Deputy Associate Administrator
for Space Science and Applications

99th Congress

Statement of

Mr. Samuel W. Keller
Deputy Associate Administrator

Office of Space Science and Applications

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

before the
Subcommittee on Science, Research, and Technology
Committee on Science and Technology
U.S. House of Representatives

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to testify before the Subcommittee on Science, Research, and Technology on the University Research Facilities Revitalization Act of 1985, HR 2823.

I am pleased to participate in today's hearings about the condition and future needs of university and college research laboratories and equipment. Much of the success which we have achieved in NASA can be traced to the cooperative, productive relationships we have nurtured over the past 27 years with our research partners in other Federal laboratories, in non-profit research institutions and industrial organizations, and in universities. Central to NASA's success has been our ability to independently manage our resources among and within such disparate institutions. For some time now, we have recognized the significant problem of obsolete laboratory equipment within the university community. We also recognize that university research facilities modernization is essential to the accomplishment of NASA's research program. However, we feel strongly that funding processes for laboratory equipment and facilities cannot be separated from current NASA management processes used in selecting and supporting university research projects in general.

The bill under discussion today would establish a special pool of funds to finance the modernization and replacement of equipment and facilities in university and college laboratories through University Research Laboratory Modernization Programs. NASA would be authorized to receive an appropriation of $20 million in Fiscal Year 1987 to begin the program; thereafter, funds would be required to be supplied by NASA from its research and development appropriation.

Although the intent of the proposed legislation is worthy, the bill would place severe restrictions on NASA's flexibility and could negatively impact both the accomplishment of our research mission and NASA's support of research at universities. Presently, it is not clear to NASA that the proposed legislation would achieve its intended objectives.

In my testimony today, I would like to provide this Committee an overview of NASA's scientific and technical programs as they relate to the university community and thereby to describe our continuing and significant commitment to equipment and facility modernization.

Introduction: NASA/University Sponsored Research

In FY 1984, approximately $220 million went to the support of colleges and universities. Estimates for FY 1985 and FY 1986 are $260 million and $300 million respectively. NASA does not identify a specific line item in the budget for sponsored efforts at universities or colleges, but rather, determines overall research programs for a given fiscal year and the amount of funding necessary for each program. The identification and funding of such research programs are made on a mission-need basis (both for current, approved missions and future planning) and not in terms of the ultimate performers. NASA then determines which aspects of its mission can best be met by in-house capabilities and which are best conducted by universities, industries, non-profit organizations, or other Government agencies. During Fiscal Year 1984, $220 million was delegated to colleges and universities, of which approximately 10% or $22 million was spent on the development, and/or replacement of equipment. In Fiscal Year 1985 this replacement of equipment is estimated at $25 million, and approximately $30 million is projected for this purpose in Fiscal Year 1986, based on the President's budget request.

The issue of maintaining first-class laboratory research equipment is an important one, and NASA, in concert with Governmental and private organizations, is addressing it. While there is no explicit provision in the budget for updating university laboratories and equipment, one of the important functions of the R&D program is to support university research groups in a manner that includes provisions for research equipment.

The following information is intended to provide this Subcommittee with a brief overview of how NASA manages its mission responsibilities while keeping our commitment to the health of the university community and its infrastructure.

Office of Space Science and Applications

The Office of Space Science and Applications (OSSA) manages NASA's major scientific and applications space flight programs and various research activities carried out with balloons, aircraft, and sounding rockets as well as ground based research. OSSA has responsibility for about 20% of the total NASA program encompassing a range of scientific and technical disciplines great breadth and diversity: astrophysics, solar system exploration, solar terrestrial science, earth science and applications, life sciences, microgravity science and applications, and advanced communications satellite technology. The OSSA program falls logically into three categories: 1) Flight Programs, a majority of which are free flying satellites which typically require 3-7 year development schedules and several years of science operations), 2) Mission Operations and Data Analysis (programs that provide for operational support to science missions), and 3) Research and Analysis (programs that provide funding for ground based research and represent the principal source for ongoing support of science investigations at universities and other research institutions). It is significant to note, however, that we support universities not only in the Research and Analysis Program, but also in our flight programs. When we select teams for our flight programs that are, in fact, also funded for calibration and test equipment and data processing equipment. This source of funds allows significant upgrading of laboratory equipment in universities participating in the flight program. To illustrate this, I would like to give an example.

The Upper Atmospheric Research Satellite (UARS) Program is a major OSSA flight program. The principal investigators in this program will each be furnished with a Remote Analysis Computer (RAC) to conduct their research. Thus, each of several universities (Michigan, Colorado, Southwest Research Institute Texas, the University of Washington, and Georgia Institute of Technology) will receive a significant computer capability to carry out the research. The capability will remain with the universities after completion of the project.

In many cases, the currency of computing capability and instrumentation can be shown to have a direct correlation with when a university last participated in a NASA flight program.

The scope of OSSA's programs, including the internal/external balance of these programs was clearly recognized in the report of the Space and Earth Science Advisory Committee on "Research and Analysis in the Space Sciences" (July 1984):

> In considering the NASA science program, it must be realized that the agency has been given the responsibility for managing and fostering programs of national significance. The importance of the R&A program within NASA can be viewed from two perspectives: as directly supporting NASA's immediate scientific goals, and as supposting the basic science that is necessary

> for achieving long-term success in the programs in the space and earth sciences for which NASA is responsible.
>
> NASA has a distinctive role as a manager of national programs in that it must integrate contributions from three diverse universities, the NASA centers, and industry. The efficacy of the total effort depends strongly on maintaining appropriate balances between these components, taking advantage of the special strengths of each, and stimulating each of them to contribute in an optimum way to the total endeavor.

The Research and Analysis, Mission Operations and Data Analysis and a significant part of the suborbital program together comprise OSSA's "research base." This research base provides ongoing support for operational spacecraft as well as the basic infrastructure of support for the conduct of ground-based activities at the NASA centers, in the universities, and in other laboratories of the Principal Investigators and Co-Investigators who are involved in space science and applications missions. A typical university research grant from the Research and Analysis program ranges from $50,000 to $125,000 per year. Following a peer-reviewed selection procedure an experiment would normally be funded for three years or more. Some grants are larger, ranging up to $1 million per year in areas where centers of specialized capabilities have developed in the universities.

The OSSA approach to assignment of flight experiment opportunities and research grants among competing scientists inside and outside of NASA may be unique for a Government that does in-house research in that it provides for independent peer review of all proposals including those submitted by in-house NASA scientists. The selection of proposals received in response to an Announcement of Opportunity are carried out through formal procedures similar to the Request for Proposal and Source Selection Board rules which govern major government procurements. These regulations provide for strict confidence of information received on competing proposals and on evaluations carried out by the Space Science Steering Committee leading to final payload selection by the OSSA Associate Administrator. The objective is to assure selection of the best flight experiments that meet criteria of scientific "merit" and "relevance" to the science objectives defined in the Announcement of Opportunity. Less formal procedures are used in OSSA Headquarters to evaluate smaller research grants and contracts, but all science proposals are subjected to peer review to assure even-handed selection of the highest quality work. The Headquarters Science Discipline Chiefs play a major role in assuring the integrity and effectiveness of the selection process.

Figure 1 provides a breakdown of the FY 1986 OSSA budget by economic sector. As can be seen in the chart, about $260 million or 16.2% of the OSSA budget is in support of university based research. Of that amount, we estimate approximately 10% or 26 million of the OSSA budget supports modernization of university facilities and equipment in direct support of the conduct of research approved by the independent peer review

Aeronautics and Space Technology

The NASA Research and Technology (R&T) program provides technological advances for future aeronautical and space systems that enable the United States to maintain a position of world aerospace leadership. The Office of Aeronautics and Space Technology (OAST) manages three preeminent research laboratories, the Ames, Langley, and Lewis Research Centers. Each center has broad capabilities for research and technology development across the entire range of aerospace disciplines and often provides the major national resource, in terms of both facilities and research personnel in their respective areas of concentration.

OAST provides strategic direction and resources for the center research efforts managed by NASA centers. This direction is responsive to national priorities, congressional emphasis and technological opportunities as put forth by the extensive system of industry/government/academic advisory committees. Projected system needs are compared against technological trends and forecast advancements to identify areas of opportunity for technological research and to provide the basis for the prioritization of resources.

The OAST university program, currently at a $50 million annual level is funded through research grants, support to research institutes, and Centers of Excellence at appropriate universities, and through other Federal agencies. These university programs characteristically address long-range, high-return and high-risk research topics. The topics and areas of research interest are known to the university community through topical symposia and workshops and are solicited by both formal and informal invitations for proposals.

The major portion (80 percent) of the OAST university program is funded through the research grant process. The program is delegated to, and managed by NASA's research centers and provides on the order of 700 grants per year to some 160 different institutions around the country. It is through this process that NASA is able to focus funds for facility/instrumentation modernization to meet specific mission requirements. One such example was the building of a unique facility at MIT to obtain useful parametric information about material damping and transient decay of a specimen while in motion under 0g and vacuum.

University Centers of Excellence have been established at six universities to develop expertise and to establish facilities and equipment in emerging fields such as composite and ceramic materials, computer sciences, and artificial intelligence. Grants to these centers average $500,000 per year per school. Jointly funded programs to encourage graduate studies in advanced avionics and air traffic control and wind shear penetration modeling are being pursued with the Federal Aviation Administration.

Each of the NASA research centers enter into cooperative agreements with colleges and universities which provide access to NASA facilities, wind-tunnels, computers, etc., for graduate students pursuing research that requires facilities not available within the university community. For example, the numerical Aerodynamic Simulation (NAS) program, which will provide the most advanced computational system in the world for aeronautics research and development, will be made available through a long haul communications network to the university community for advanced research.

Approximately 15 percent or $8 million of the university program supports generic basic research. The $8 million provides for university needs in graduate and undergraduate curricula development and for the important Fund for Independent Research (FIR), a Fund designed to encourage novel and basic investigations more fundamental and/or advanced than the focused OAST research program. The FIR is managed by the research centers. About one hundred grants totaling $4 million ($40,000 average) are the result of awards to both solicited and unsolicited proposers. This program is managed by each center's Chief Scientist and a Basic Research Council of leading experts from NASA's centers. Other university programs specialize in education and training in fields such as computational fluid dynamics and aeronautics research.

Each OAST research center publishes a Research Proposal Submission Guide defining the submittal process. The National Research Council participates in a cooperative process of abstracts of NASA research needs. The centers' Joint Research Institutes serve as networks to the university community. The University Space Research Association provides another networking source of NASA research guidance. Furthermore, there are regular solicitations on both specific and broad research areas of interest that are pursued through Announcements of Opportunity or "Dear Colleague" letters.

Proposal evaluation and selection is primarily an internal process but is frequently augmented by support from university and industry specialists. Research results and products are evaluated by both center and outside peer review groups. A most productive technique has been to assemble all grantees and contractors for a review of research in areas of common interest. All grants and contracts require a final report submittal and they are published through NASA's Scientific and Technical

Information Facility (STIF). Many researchers, of course, publish their results in professional journals and in conference or workshop proceedings. Feedback from the research community occurs both informally through contract and grant monitors and more formally through those experts that participate in the Advisory Groups.

Figure two shows a distribution of the OAST budget by economic segment. Of the approximately $50 million spent at universities around 10 percent or $5 million is in equipment and modernization to support OAST mission research. Related to this, as previously mentioned, the funding of University Centers of Excellence at six universities establishes a unique institutional capability and infrastructure on the campus that enables the OAST program to advance in new and emerging disciplines.

Summary

NASA supports many of the principles inherent in the University Research Facilities Revitalization Act of 1985. I think it is clear from my remarks that through NASA sponsored research we are currently supporting university modernization in a manner consistent with our mission needs and our budget. However, in a period of national budget constraint, NASA has serious reservations about any approach that would restrict our flexibility to make sound programmatic decisions which we feel are in the national best interests of accomplishing our mission. We also believe that a new set-aside program would result, in the long term, in decreased funding to meet our research objectives. Additionally, a separate approach to alleviating the problem through set-aside programs in numerous agencies would increase the overall institutional costs for administration and control. NASA is acutely aware of the need to modernize university laboratory equipment and facilities and we will continue to focus our efforts on the problem through our traditional university sponsored research. The proposed legislation would not, in NASA's view, improve the current situation. Therefore, we do not support H.R. 2328 in its present form.

Mr. Chairman, that concludes my testimony. I would be happy to respond to any questions that the Subcommittee may have.

FIGURE 1

OFFICE OF SPACE SCIENCE AND APPLICATIONS

DISTRIBUTION BY ECONOMIC SEGMENT

FY 1986 BUDGET REQUEST

(DOLLARS IN MILLIONS)

$1613.2 M

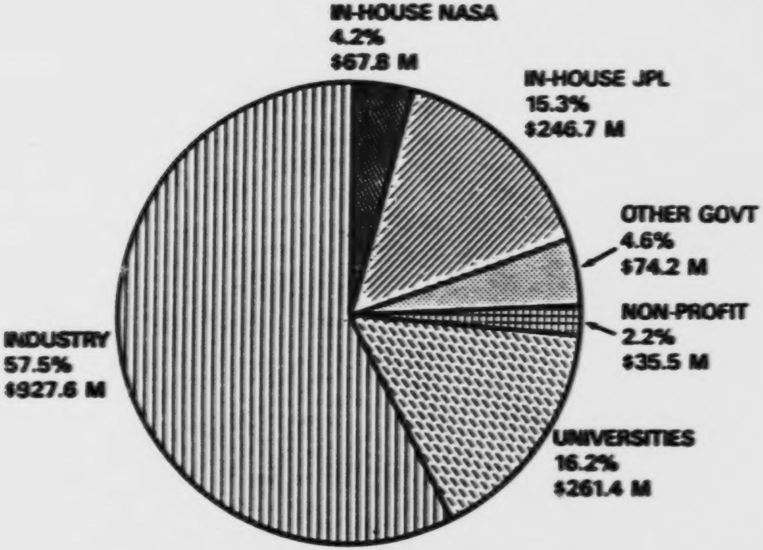


FIGURE 2

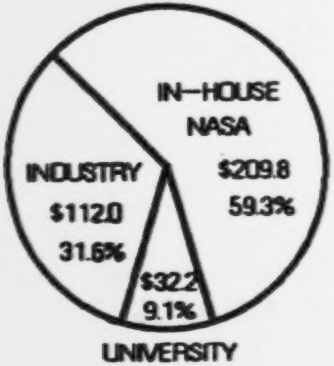
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

DISTRIBUTION BY ECONOMIC SEGMENT

FY 1986 BUDGET REQUEST

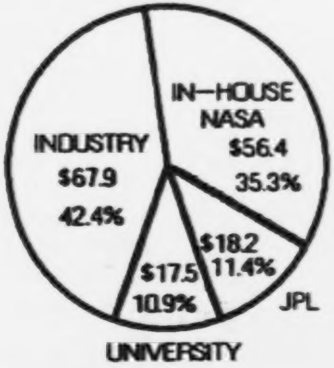
(DOLLARS IN MILLIONS)

AERONAUTICS



TOTAL $354.0

SPACE



TOTAL $160.0

Mr. **Walgren**. Thank you, Mr. Keller. We appreciate that.

Dr. Trivelpiece.

Dr. **Trivelpiece**. Mr. Chairman, good afternoon. It's nice to see you again today.

Mr. **Walgren**. You back so soon?

Dr. **Trivelpiece**. I suspect—I heard your comments of the previous witnesses. I suspect a lawyer actually does know the strategy by which the Department goes about allocating its funds. But just for the record let me point out that what we believe we do is to try to identify the best qualified performers and then seek to have the most excellent research done under those circumstances. That has been a longstanding strategy and that strategy has resulted over the years in DOE-supported research, producing something in excess of 40 Nobel Prize winners of American origin, either supported in whole or in part, through the Department funding.

Now, that same sort of a strategy also involves then a great segment of the university community supported by the Department. I think in many cases this is not fully recognized or completely appreciated, but something in excess of 6,000 graduate students receive their educational support in various areas of basic sciences through the support that the Department provides.

In that regard, Secretary Herrington was at a dedication ceremony recently and chose to comment on the idea that national security isn't just our armed services but it is also the talent base of our Nation that needs to be strengthened to improve our industrial competitiveness and quality of life.

I want to comment just a couple of minutes here on some of what DOE does. It supports universities in three ways. There is about $345 million that goes directly from the Department to academic institutions for various kinds of research that is funded on a competitive basis. Through the laboratories in the DOE system, the national laboratories, something like another $400 million goes in the form of subcontracts or activities that support researchers at universities.

If you then look into the idea of allocation attributing to some of the other facilities, of some fraction of support for the academic community, you probably could come up with another $600 million. For example, the Fermi National Accelerator Lab, serves about a hundred universities and they come there and do their research, so it's a national facility. And in that regard, this kind of concentration of facilities and the sorts of things that you're trying to look to do and to be concerned about. There was a time in the United States when virtually every major academic institution had some kind of a state-of-the-art accelerator and the students were capable of working at that university, using that equipment, and being capable of doing world-class state-of-the-art research.

As that field advanced, the cost of the facilities to make progress increased substantially, and groups of universities would form to manage accelerators of higher quality and higher energy and the like. The end state of that in the United States is the Fermi Lab, the Stanford Linear Accelerator Center, and Brookhaven National Laboratory. There are three high energy physics facilities used by the academic community.

We have reached the point, in effect, that we cannot afford to put world-class facilities at each institution, and so if a set-aside program or a distribution where that amount of money that is spent on high energy physics were distributed uniformly across the United States, I suspect we would not have the kinds of world-class facilities that we do that lead to the kinds of research that we're capable of doing.

Another aspect of this is that the Energy Research Advisory Board, which is the senior advisory committee in the Department, suggested to the Department that we try to make available some of our facilities for academic-type research in a manner that we have not been doing in the past. And the Department has tried to respond to that in a variety of ways, including bringing something like 52 high school students last summer out to the Lawrence Livermore Laboratory and letting them have an opportunity to learn how to operate and work on super computers. The only problem we had with that was that we changed their passwords after they left, cancelled all the passwords immediately. There are also used equipment programs. We have research instrumentation programs, and there are something like 50 user facilities which the Department makes available both for industrial scientists and academic scientists.

I think I agree with the witnesses here in the sense that we're concerned with the idea of a set-aside, having the elements of future problems built into it, even though it is laudible in its intent to try to solve a problem. Certainly the Department of Energy has had its own university facility revitalization activity with the help and guidance of some Members of Congress, as you're well aware.

There is no magic solution to this problem and the need for trying to solve it is very clear. There are things, however, that I think make more sense than perhaps a set-aside, that to some extent the Federal Government can't solve all the problems of the various regions of the United States, however laudible that particular goal and objective might be. So that to some extent those areas that are likely to benefit I think need to put some effort into the kind of boosterism and so on that causes the facilities to appear.

In that regard, the Department in the past has caused facilities to come into existence in the way of buildings at academic institutions, in a way where the institution takes the risk up front and the Department, through use charges, pays back the building. The Michigan Plant Sciences Laboratory is an example. Michigan went out—Michigan State went out and, at its own risk, put up the building, and on nothing more than a letter of intent from the Department, that it was our intention to continue funding that activity with an appropriate use charge, the cost of that building was paid off.

Now, that does still, in the long run, amount to the same amount of money. The Department did, in effect, buy the building. It also does things like the Princeton Plasma Physics Laboratory, where that entire facility is on the Forestall site of the Princeton University campus, and there is a research radiation laboratory at Notre Dame that does this.

To some extent, I think academic institutions need to look to the other side of the problem, and that is that indirect costs, if appropriately applied, probably could do something to help solve the problem, that small businesses need to have multiple overhead rates in order to have the kind of overhead G&A and fee structure that they need to compete in the various markets and arenas in which they are working.

The present system in many academic institutions, which has a fixed overhead rate, is an accommodation to the concern that faculty have that somehow any overhead or indirect is simply money being stolen from them, whereas, in fact, an indirect cost base is something that is a real activity and is something that needs to be done. The present circumstance, where experimental programs pay, say, 50 percent overhead rate, and a theoretical program has an overhead rate of 50 percent, one of them is either doing very well and the other one is not doing very well, because one of them clearly does not need the level of overhead support that they're being charged to contract. So it may well be that some more sophisticated use of multiple overhead rates by academic institutions could go some distance toward helping alleviate this problem.

I agree with one of the previous witnesses, that the use of rent charges, that the Federal Government should pay an appropriate cost to the facilities which it uses and, therefore, the current level of allowance for rent cost and depreciation I think is unrealistic. Whether or not that can be fixed easily or not, I don't know.

But as with my colleages here, I think we are concerned about the idea of a set-aside and that that, although it might alleviate the current condition, is likely to generate problems down the road and, furthermore, would tend to subtract from the already rather strained base of activities that supports an excellent research capability that the United States needs to support the talent base as Secretary Herrington said in his recent speech.

Thank you, Mr. Chairman.

[The prepared statement of Alvin W. Trivelpiece follows:]

Statement of Alvin W. Trivelpiece
Director

Office of Energy Research

Department of Energy

before the

Subcommittee on Science Research and Technology

of the

House Science and Technology Committee

October 30, 1985

Mr. Chairman and Members of the Subcommittee on Science Research and Technology:

I appreciate the opportunity to appear before you to discuss problems facing the university research community in modernizing research facilities and laboratories. H. R. 2823, the University Research Facilities Revitalization Act of 1985, introduced by Chairman Don Fuqua, recognizes the importance of addressing the need to modernize these facilities in the near future.

Background

Before I comment on the proposed legislation, let me briefly review the Department of Energy's (DOE) relationships with and support of the university community. A strong university research infrastructure is essential to continued advances in all energy-related fields as in other national science and technology goals and initiatives. Therefore, DOE has extensive research and related manpower development programs with universities and colleges in all of our mission areas. Our purpose in supporting university-based research is twofold: (1) to expand the science and technology base underlying all of the energy R&D and technology development programs and (2) prepare and train the next generation of scientists and engineers needed for future national scientific and technical research programs. DOE provides support for university research in essentially two ways: through the direct funding of university research projects (totalling $345M in FY 1985) and the indirect support provided to university scientists and students through programs and resources at the DOE National Laboratories and other contractor research facilities (totalling approximately $400M in FY 1985).

We have been involved over the last several years in taking actions designed to significantly strengthen our university support base. The Energy Research Advisory Board in 1983 assessed the state of the Department's relationships with the university community and proposed a number of recommendations designed to enhance these relationships. Since that time, we have significantly expanded support for faculty and student participation in national laboratory research programs, increased funding for university research through the energy technology programs, initiated support for the purchase by university scientists, on a competitive basis, of state-of-the-art scientific research instrumentation, and streamlined and simplified our university procurement policies and procedures.

In 1984, the Department issued agency-wide policy guidelines on the conduct of relationships and programs between DOE and the university community. These guidelines have been very helpful to us as we seek additional ways to involve university faculty and students in our various energy research and technology development programs.

The DOE and other Federal R&D agencies have noted with growing concern the problems facing the university research community in renovating existing and building new research laboratories and facilities. The problem is real. Estimates of the costs of fixing or replacing university research facilities range up to $50 billion depending on whose survey is used. Based on a 1984 interagency survey, that the university community will need to spend up to $1.3 billion per year over the next five years just to keep up with necessary remodeling and renovation of existing laboratory research facilities.

DOE supports a number of specialized university-based research facilities and laboratories, such as the Plant Research Laboratory at Michigan State University, the Bates Linear Accelerator at MIT, and the Radiation Laboratory at the University of Notre Dame. DOE provides the operational expenses of these dedicated research facilities including capital equipment purchases and building renovations when required. Support is also provided for the purchase of state-of-the-art scientific research instrumentation for use by university scientists. I am pleased to note that on a national basis we are beginning to make a noticeable impact on this problem.

In addition, the DOE and its predecessor agencies have for years supported the broad use of special Federal laboratory research facilities by university scientists. A major DOE mission is to ensure that the research laboratories and facilities at our major national laboratories and contractor research facilities are available for use by university and industrial scientists. There are some 50 such designated user research facilities in our laboratories. They range in size from the particle accelerators at Fermilab and Stanford to multidisciplinary science facilities such as the National Synchrotron Light Source at Brookhaven and the Combustion Research Center at Sandia-Livermore; to smaller, specialized research instruments and facilities at each of the major laboratories. The common element in these facilities is that they are open for and indeed intended for use by university scientists and students who do not have direct access to such instrumentation and resources on their own campuses. In FY 1985, DOE spent $235.5 million in support of these facilities. We estimate that 2000 university faculty members and 3000-4000 graduate students came to our laboratories in FY 1985 to use our research facilities for research and related training purposes. In a growing number of scientific research fields, it is not possible to carry out frontier level research without taking advantage of the resources, instruments and laboratories at these national facilities.

H. R. 2823

Now, with this as background, let me comment on the proposed legislation. H. R. 2823 would authorize the creation of university laboratory modernization programs in the six leading Federal R&D agencies. Start-up funds would be authorized in FY 1987 for each agency with subsequent year funding keyed to a percentage of each agency's total funding for university R&D. The intent of this legislation is laudable. It has already served a major purpose as a catalyst for discussion both in Washington and in the academic and private sector communities about what can and should be done to help meet this national need. However, the Department cannot support the legislation in its present form because its inflexible, set-aside approach to future year funding will have a serious impact on total Federal support of university research. In order to meet the requirements of the proposed bill, Federal funds would have to be diverted in future years away from such categories as graduate student support and research project support toward facilities funding. While a reassessment of national priorities on university research funding may indeed be in order, this should not be done precipitously without due consideration and in partnership with the academic science community.

An assessment and reevaluation of Federal support for universities are in fact underway through the work of the HS&T Science Policy Task Force. This assessment is fully endorsed by the Department of Energy. Many of the issues being examined by the Task Force are relevant to today's discussion. In addition, in July of 1984, I participated in a Government, University, Industry Roundtable (GUIR) conference on the subject of university research facilities. There was agreement on the importance of the problem, but not on any single approach to solving it.

While the proposed legislation is not, in our opinion, the preferred approach toward solving this problem, something needs to be done and soon. A comprehensive, in-depth analysis on a national basis and by field of science and engineering of the magnitude of this problem and its associated costs is needed. New partnerships between the Federal government, state governments, private industry and foundations and the universities themselves need to be explored to meet these needs.

On the state level, some states through development planning and in close cooperation with the private sector, boosterism, bond drives etc., are taking major steps to solve the problems in their regions. More such ingenuity is required in an area where involvement by the states, business and the technology community are more important ingredients to solving the problem, than Federal set aside actions to temporarily alleviate it.
We look forward to working with the Committee in exploring ways that the universities, government and private sector can seek appropriate solutions to the problem of modernizing research facilities at our universities and colleges.

In summary, there is a major problem of research facility obsolescence at our nation's universities, and science suffers because of it. But the solution goes beyond the solitary role of the federal government. There needs to be a joint effort among the universities, states, and industry to share the reponsibility for modernization and long-term maintenance of the quality of scientific equipment and facilities at our nation's universities.

This concludes my remarks, Mr. Chairman. I would be pleased to answer any questions at this time.

Mr. **Walgren**. Well, thank you very much, Dr. Trivelpiece. And I want to really apologize to you for what was, I think, a facetious remark on my part, and I meant no disrespect to the quality of the research being carried out at the Department of Energy.

Dr. **Trivelpiece**. We try to do the Lord's work, also. [Laughter.]

Mr. **Walgren**. I really was thinking not so much about the quality but the process of a competitive decision and how obvious that process is from the outside. I don't know much about how a lot of agencies do that, and my only real exposure has been to NSF, which does it totally outside with citizens it calls in. I was simply trying to contrast the differences in process. But certainly I meant no reflection on the quality of the selection that is made.

Dr. **Trivelpiece**. I didn't assume that you did. I just thank you for a nice opening line. [Laughter.]

Mr. **Walgren**. OK.

The concept of relying on the indirect cost recovery certainly is sound and certainly is the most flexible thing. The difficulty, I gather, is that some institutions would require more than a letter of intent and in some instances the Federal agency would not be in a position to give the assurances of future use that would be necessary to support a mortgage loan, I guess.

Dr. **Trivelpiece**. That's correct. It's difficult to do, at least in our agency, something other than a letter of intent. We can't guarantee it because obviously the appropriation takes place on an annual basis. Unless the entire amount were appropriated in the end year, it wouldn't be possible to do that without at least some change in the law.

Mr. **Walgren**. And would the thought that either some of these facilities may have very specific uses that might not be the subject of interesting research 5 years from now or 10 years from now. The school might really be in a difficult position, having built it and borrowed the money and then have no takers for the use of the facility, I guess.

Dr. **Trivelpiece**. Mr. Chairman, I——

Mr. **Walgren**. I wish there were ways that we could strengthen that mechanism because it has some real advantages as to flexibility.

Dr. **Trivelpiece**. May I comment on that, please?

Mr. **Walgren**. Sure.

Dr. **Trivelpiece**. I think one of the things is that talent should be the first ingredient that an academic institution seeks to acquire, that if you have a collection of talented individuals it is probably easier to acquire programs; if you acquire programs, it's probably easier to acquire the necessary facilities that make those programs work well. To start with the bricks and mortar first, with the expectation that that will attract talented people, I think is in some cases misguided, that the core of the recruiting activity ought to take place with seeking the best qualified individuals first.

Mr. **Walgren**. Which makes it even harder to use the indirect—or to rely on indirect cost recovery to be able to do that, because in a sense you're—well, maybe it doesn't follow.

Looking back on just the pure injection of money and facilities that we did at NIH, as Dr. Wyngaarden testified to, would it be preferable to do things that way? If that were an option to us—perhaps that's not an option. But if you had your druthers, would you want to see the Congress trying to simply direct the funds into construction in an area, regardless of—well, I don't know how those funds were distributed. I suppose they weren't linked with a specific research proposal.

Dr. **Wyngaarden**. They were distributed competitively and, therefore, they frequently went to those institutions that had a very strong research base. There was a requirement for a description of the ongoing research and plans for the future, but they did represent facility construction for broad-gauged research, so were not tied, for example, to individual disciplinary requirements such as the subsequent and now existing authorizations required.

But in answer to your question, I think that it is a possible way to proceed. It certainly accomplished what it set out to accomplish in the fifties and sixties. Unfortunately, there were no appropriations for general construction since 1968 and the authority was repealed in 1974, so we've not been able to engage in general facilities construction since that time. But I would make a general point, that the investment in cancer facilities in the early 1970's, and ongoing to the present, has been an extremely important factor in our capacity to respond to the AIDS crisis. Much of the work that has been developed in the extramural world relating to the virology of the AIDS problem has been done in the cancer centers, and some of the testing of clinical compounds is being done through those facilities.

It underscores the point made earlier, that this is an investment that needs to be renewed repeatedly. It is true, I think, we respond to crises, but I think it is also true that we would profit from having an ongoing authority so that we could make annual investments in facilities and equipment just as we do in the research project itself. So standby authority which would permit us to do that on an annual basis, perhaps with some superimposed deliberate construction authorities for special needs, would be one way to approach the problem; together with a greater use of the private money market and retirement of costs through depreciation and interest charged as an indirect cost.

I think this pluralistic approach might very well be an alternative to this rather rigid set-aside.

Mr. **Walgren**. Presently you wouldn't have that kind of ongoing authority to invest in a building, would you?

Dr. **Wyngaarden**. No, sir, we don't have that, except in these three fields I mentioned—Cancer, Heart, and the Eye Institute.

Mr. **Walgren**. And the other agencies would not have that ability to take a research dollar, unless it were a line item by the Appropriations Committee, and build a certain facility?

Dr. **Trivelpiece**. Well, we have the authority to request it and can spend funds on buildings, and have, but several academic institutions——

Dr. **Wyngaarden**. I think the NSF has more flexibility then we have. I am not entirely familiar with their authorizations. But they have been investing in construction more consistently than we have been able to do.

Mr. **Walgren**. Would the others comment on restrictions in using money in that way under present law?

Dr. BENTLEY. As far as I know, we would have in the Department of Agriculture construction authority for a Federal facility. It largely would be really with the Agricultural Research Service, and that would have to be line itemed for construction. We have even had difficulty getting funds to be designated within the budgets for maintenance and repair. We have now established such a concept within the Agricultural Research Service to maintain our existing facilities. So yes, we could not do that in this—under our existing authority.

That's why I would like to—if I may just expand a bit on the matter of the facilities in the agricultural sector, veterinary medicine and forestry probably would also fall under this category. Many of the joint programs, where the funding we put to universities is on a cooperative basis, there is very little, if any, indirect cost charges assessed to those funds by institutions because they're cooperative and have a long standing, going back some many—going back to 1887. So there isn't recovery—in the first place, the amount of money would be relatively small, since these aren't large programs. So that's one consideration.

That's why we think that we're putting forth a great deal of effort and we think there's a great deal of merit in getting the type of a program that we could provide some funding from the Federal Government to help provide facilities on university campuses—it could be others, but primarily university campuses—where we would be on a matching basis and use a competitive approach, and it would be allocated to the Secretary to make those choices. Because the amount of money needed is so large for the total system, it would be very difficult to get enough funds to handle everything that's needed and legitimately needed in the system, we would have to have some type of a priority way of allocating the funds. We think it should be leveraged through the matching or some type of formula of that type.

We have in our area identified places of need. We could also help develop a capacity to meet certain new and emerging problems—although I shouldn't use the word problems—really opportunities that we have in research right now in molecular biology as it's applied to agriculture, as a high need requiring special new facilities. We're requiring all kinds of investments that we do not now have. The institutions themselves have identified a need for something on the order of $70 million of funding of this type. If there could be some assistance from the Federal partner in this effort, it would be greatly appreciated. Many universities have had to build—cooperative programs have built facilities and utilized—and have provided the space, laboratory, offices, et cetera, for Federal employees from State funding sources. That's true in the case of the institution that I came from, the University of Illinois at Urbana-Champaign. When we built new facilities, we actually provided space from Federal funds—from State funds—with full recognition of the formula allocating process to provide these offices.

As you know, on boards of higher education in the State, you have to justify things down to the last square inch virtually, and so we named people and decide—and showed the kinds of facilities they have. So there has been this cooperation. I'm sorry to take too long to do it, but there's a little different part of the same general, complex problem that we all represent.

Mr. **Walgren.** Mr. Keller, did you want to add something?

Mr. **Keller.** Mr. Chairman, I haven't studied this in detail—but I think within NASA we have authority to allow a portion of our grant money to be spent for brick and mortar, so to speak, or facilities or equipment. I don't believe that the same prohibition, line-item prohibition that applies to a Government facility would apply to something done by the university. So I don't believe that's a problem.

However, I think it might be worthwhile to look at the question of the authority of the Agency—and I suspect this is fairly typical. We are mission agencies, in general, and NASA has authority to spend money to carry out the mission assigned to it. As I listened to some of the comments earlier in the afternoon, it is apparent that the interest is directed toward all universities, and particularly those who don't have research programs, or don't have good research programs. I am not sure that the Agency, as it now stands, has authority to operate a program for the general aid of laboratories in the educational community. We operate on a peer review process. In fact, I think we're the only Government Agency with an internal research capability that makes our internal researchers compete against the university world in a basically outside peer review process. But our researchers in our own laboratories get their salaries paid, but the money that supports a research program has to be one in competition against the outside world.

But that tends to drive us to high quality. Maybe more research for the buck is not the best way to put it. But, in essence, I believe we have an obligation to carry out the most effective mission program we can as the mission is assigned to us by the administration and the Congress. That drives us to pick only the best. It's a very, very competitive process. I don't know that we have the authority—and certainly, we probably don't even have the skills—to run a program that is directed to—I don't want to use the word subsidization—but aid to or an across-the-board taking into account considerations like geographic diversity, various minority interests, the development of the emerging universities, the small school versus the big school, the State school versus the private school. These are more the province, I suspect, of agencies that have that kind of expertise, not the people like ourselves.

Mr. **Walgren.** Well, I appreciate that.

Mr. Boehlert.

Mr. **Boehlert.** Mr. Chairman, I'm just perplexed, to be honest, because we hear constantly that there's a real crisis with respect to the lack of adequate facilities and equipment at our colleges and universities, and we're lobbied extensively and enthusiastically from academia for something, something to—some action on our part to solve their problem. And then we hear all of you tell us how laudible the intent is and how you support the intent, but you're against the specifics.

I don't know if we keep doing things the same old way if we're going to make any progress toward solving the basic problem that has created the crisis. I mean, I hate to draw an analogy, but in this town everybody is talking about Gramm, Rudman, and Hollings and everybody says "we don't need that legislation; Congress can do it or the President can do it." Baloney. Nobody's doing it. They don't have the guts to do it. We now find ourselves in a situation with a $2 trillion national debt. We're spending $15 million an hour, since you people started testifying, just in interest on the national debt. So obviously, we need something jammed down our throats to force us to do something that needs to be done, and I am just wondering if we don't need this measure to force us to do something.

I'm worried about it. I know what the problem is, and I don't want to take a dime away from research, not one dime. But I also know the realities and the budgetary constraints, so if this legislation is passed some money is going to come away from research for the basic facilities.

But then I go to Dr. Wyngaarden's statement—and I have underlined this and I love it, I agree with it:

> The research potential of each institution is dependent on the condition of its research infrastructure, that is, people, equipment and facilities. We are keenly aware that today's scientific investigation is next to impossible without state-of-the-art facilities and instrumentation.

Well, I don't mean to make a long speech—I should tell you, all of you, that one of the reasons I'm here on this committee, Congress always operates in strange ways. Science and Technology was a natural assignment for me because I got a "D" in high school physics. [Laughter.]

But I agree, Dr. Wyngaarden, with your statement. We just—you know, scientific investigation is next to impossible without state-of-the-art facilities and instrumentation. We don't have it out there in so many places where we want to see it. And yet, if we keep going the way we are going, with your flexibility that you desire—and I would like to have you have the flexibility—but we're not getting the facilities and we're not getting the equipment. How do we do it absent legislation like this that forces it?

Dr. **Wyngaarden**. My personal view is that the first step would be to provide a general authority for construction that we once had—even without specific appropriations for such construction until the economy permits that. That would give us the flexibility of deciding program by program where construction is needed.

For example, we probably wouldn't divert any funds from the cancer program into additional construction, at least not on a large scale, because they already have that authority and they have been building facilities over the years. Many of the other institutes would need this. We have a few situations where most of the work is intramural. For example, the National Institute of Environmental Health Sciences has a relatively small extramural program in the universities and probably wouldn't opt to put its resources into construction. And we have other institutes that are at the opposite extreme, where virtually everything is done in the university, where construction support would be more necessary.

Mr. **Boehlert**. So you're saying your hands are tied now?

Dr. **Wyngaarden**. Yes, that's right.

Let me just point out one additional fact, and that is that this set-aside of 10 percent would reduce our ability to fund research by 2,000 awards per year. We just managed, with the help of Congress, to achieve an increase from the 5,000 base, which we've had for the last several years, up to 6,200. This would bring us back down to somewhere around the 4,200 level if all the funds were taken out of the new and competing awards. Obviously, there are other ways to distribute the impact, but that's an example of its effect.

Mr. **Boehlert**. Sure.

Dr. **Wyngaarden**. So that's a fairly stiff jolt—for a good cause, I realize. But it seems to me some more flexibility, perhaps a phase in of the 10-percent figure, or a lower figure, or a greater reliance on the private sector mechanisms along with these, might get us to the same point. I suspect that if the scientific community were given a chance to choose this particular approach as specified in the bill, or continue support of the research, they would opt for the research support for the moment, as desperate as the facilities situation may be.

Mr. **Boehlert**. Mr. Keller, did you want to——

Mr. **Keller**. Yes, sir, Mr. Boehlert.

I would add, I agree with that comment. I think there is a real problem out there, and I think we all do. The real conundrum we come up against is how does one take a limited amount of resource and spread it around in the best way, recognizing that if we are good enough to do it in the best way—and maybe we're not—there still isn't going to be enough.

I was in a meeting about 3 weeks ago when my own laboratory directors, Government people, came in with a demonstration that we spend 10 percent of what private industry—people like the Bell Labs and the major research facilities—spend for replacement and upgrading, 10 percent of what they spend. So we have within the Government and within some of the industrial community, in the nonprofits as you heard today, and the universities, an across-the-board problem. I suspect that we approach the solution in what some would describe as an inequitable approach. When I get a good research proposal and I select that proposal, I make sure he has the equipment he needs to do his job.

Mr. **Boehlert**. Supposing the research proposal comes from—it's an excellent proposal but they don't have the equipment and facilities; then they're ruled out, right?

Mr. **Keller**. Well, they probably are. But you very seldom get that. The people who have the good researchers usually have enough facility to get there.

Mr. **Boehlert**. Which comes first?

Mr. **Keller**. I would agree with the order that was cited previously. The first thing to do, you get good faculty or good staff. Buildings or programs do you no good until you have that.

Mr. **Boehlert**. Pause, if I may.

How do you get good faculty and good staff if you have a major deficiency in your equipment and facilities?

Mr. **Keller**. Well, you build it up gradually. We have an interesting exercise going on now with the University of Puerto Rico which we are supporting in the development of a research capability. We have encouraged them, and they are now out recruiting, and they have gotten—and this is in the meteorological sciences and marine sciences—they have recruited about half a dozen really top-notch people who are researchers in that field.

Now, we will see to it that they get funded to do the kind of a program that you can do with that level of activity, and they will gradually, over a period of years—and it will take them years—build up a capability, and we will consciously work with them to try to ensure that they get the support they need. Now, if it turns out they need $100,000—or $100 million building, I can't buy it for them. But that doesn't normally occur.

Mr. **Boehlert**. But you are somewhat unique in that respect. You can provide some money for facilities.

Mr. **Keller**. I provide program money and they will use it in various ways. But they won't put a lot of it in facilities. But by the time they need facilities—now, if you're looking for a linear accelerator, or if you're looking for a large vacuum chamber, or the kind of facility that you need for a unique program, you're very far along and now more and more you don't get that facility. We do the same thing as the Department of Energy. For example, we recently at the Ames Research Center outside of San Francisco put in I guess what is right now the largest super computer around, and we are consciously dedicating a significant amount of time on that computer to the university community. Now, they'll operate through satellite communication links, but they no longer need to have that facility on campus. If that's the kind of thing they need, we can provide it to them.

Mr. **Boehlert**. Yes, Mr. Chairman.

Mr. **Walgren**. If the gentleman will yield, that strikes me as not a very competitive process that you just outlined there. You're getting quality, but you're getting quality because you specifically decided in advance where you were going to do it and who you were going to do it with. And you didn't—you sort of made that happen, as opposed to considering a range of competing proposals.

Mr. **Keller**. That's right, Mr. Chairman. But if you look at the program we have——

Mr. **Walgren**. We're always told that you can't do that, that it has to be this competitive application process where the best is chosen, the best proposal is chosen, as opposed to the agency deciding what it wants to do and then making sure that there is quality wherever it has chosen to do it.

Mr. **Keller**. We ordinarily do that. In the case of the University of Puerto Rico, it was selected under one of the minority university programs that the agency supports and was a unique case. That normally would not happen that way, but I pointed out that it can. And the selection process there was different.

Mr. **Walgren**. I see. I'm sorry.

Mr. **Keller**. But we ordinarily would proceed in a competitive fashion.

Now, the practical problem is we have about $220 million a year spent in the university community. Ten percent of that is $22 million a year. And if you divide that by the number of colleges and universities in this country, you don't get a very big facility.

It really says that with the kinds of moneys that we're talking to, if you're going to give anybody enough to make a meaningful addition, it's a fraction of 1 percent or maybe 2 percent a year and somebody has to wait until about the year 2050 for their turn to come around.

So really first-class research is expensive and the kinds of dollars we use will only support indepth activities in a limited number of places.

Mr. **Boehlert**. I guess we don't have any problems that money wouldn't solve.

Mr. **Keller**. There probably are some, but it would help.

Mr. **Boehlert**. In terms of the subject matter at hand.

Dr. Trivelpiece, did you have a comment?

Dr. **Trivelpiece**. Well, there are two kinds of things. One is a problem and you can solve problems, and the other is a condition and you can alleviate conditions. As a problem, I think this have versus have not is probably unsolvable within the resources that the United States Government could probably bring to bear on the problem. In other words, what you're talking about is alleviating the condition. If you alleviate the condition, the condition will again grow worse at some point down the line. And I have no doubt that this is happening with the university instrumentation. Many of us were involved in an activity that focused on the fact that there is an inadequate quantity of $100 thousand to $1 million pieces of equipment in the academic enterprise around the United States, and DOE and the Department of Defense, the National Science Foundation and others put money into specific university research instrumentation programs. We put about $5 million a year in it. It is certainly helping alleviate the condition.

But you could put probably a substantial 100 times that amount of money in. It would solve the problem or alleviate the condition temporarily, but then maybe beneficially you would find things would grow to where once again you would be at the margin of going through hearings like this, trying to figure out what is wrong with the next generation of the marginal have nots who would like to also get in the game.

I don't know how we afford to provide world-class facilities at every academic institution that aspires to a broad based, degree granting, advanced degree granting capability. It's a very difficult problem and certainly we are not taking advantage of all the talent we have out there, and this would help. It's not clear to me that what you propose to do solves the problem. It may temporarily alleviate the condition. But as I say, we don't support this particular embodiment of what you're trying to do, although very sympathetic with the problem, and I deal with it all the time with the people who are affected by it in the have not and the have communities.

Mr. **Boehlert**. And none of you are enamoured with the set-aside, the 15 percent set-aside.

I know you can't expect that every college or university research activity will evolve into a world-class center, but don't we have a situation where we're taking care of the few—I have Cornell in my district, for example, and I have Utica College. Cornell is blessed. They're happy. They like what we're doing down in Washington. Utica College isn't even in the ball game, and I don't see any change. I think that's what we're trying to do when we're talking about the set-aside, to try and make it possible to broaden our base, not with the idea that a Utica College, for instance—which happens to be my alma mater—will become a world-class institution, but at least that it'll be a participant in the process and maybe have something to offer.

Is that wrong to think in those terms?

Dr. **Trivelpiece**. It's a quantitative problem, not a qualitative problem. I think qualitatively you're exactly right. Quantitatively, it's very difficult to understand how to accomplish this.

Mr. **Boehlert**. Dr. Bentley, did you have something you wanted to——

Dr. **Bentley**. I can't refrain from commenting—I spent most of my life in universities, the University of Illinois, and listened to all of these arguments over and over again.

It seems to me that we, in higher education and looking at institutions, we have to begin to realize something that Dr. Trivelpiece pointed out, that all institutions can't be the same. And one of the things in terms of resources of a world-class program, I think—and this is now my bias—that we have not done enough to recognize, say, the quality teaching institutions and so on. We have done very little to help. We have tried to think of the rubric that we've used in terms of Federal support has been largely aimed at developing a research capability and getting frontiers of science. There is a role of the teaching institution. I think in agriculture—And then the other thing that must be stressed, and even though we have a great deal of commonality here in these four agencies that are represented here, there is also a great deal of differences.

In agriculture there are quite a few appropriations made for facilities through various mechanisms other than review of high priority needs and so on. Some of that, if we could be sure that we went through a process of looking at priorities and determining within institutions what kind of facilities we have, so that we could spread this around, but also identify those places that have the greatest capability to answer given kinds of problems, and then allocate some resources on a matching basis and a competitive basis, I think we could do more to answer some of the questions.

Then the final thing I want to say is that we think that where there is a need for a set of institutions for which a given agency has responsibility, then I think there has to be some special funds made available in the Congress, and that's what the Congress has done with the so-called 1890 group of institutions, to provide modest funding, about $10 million a year for 5 years. It has been very helpful to those institutions to improve some of their teaching facilities, some of their research related teaching facilities. I think this will have to be done in order to answer some of the questions that are raised here, but not all of them.

Mr. **Boehlert**. I hope you don't get the impression that we're in an adversarial relationship. It's just from our end of the table or desk or something we just—I'm so sympathetic when I go to the college campuses and tour around and see some of the facilities and listen to them talk about the need for equipment and everything. I know the reality. The ideal situation, of course, would be that this facilities bill would be separate and distinct and we'd have all the—we'd have the money for that, so that you could use discretion in distributing it around our universities and colleges and would not touch in any way, shape or manner your other funding for research. That would be the ideal situation, but I'm afraid that that's not going to be. So we're going to try to come up with something.

I thank all of you for what I consider to be very excellent, helpful testimony.

Mr. **Walgren**. Would the gentleman yield in pursuit of one line?

I'm wondering if there isn't something in—I feel sensitive to this concept of locking sections of the research community out of these facilities, particularly if you do it on a very disciplined merit competition where there are only going to be a few winners and a host of applications that are not funded, and if it's true that you can only do this kind of good research if you have the facilities and the infrastructure to support it, then those whose awards are not picked up will become unable to compete to do the research at all.

It's a little bit different than when we were just doing research on a peer review basis because if you didn't get approved this year you come back and apply next year, but next year in this area you will find yourself competing with proposals who have the facilities and you don't have the facilities and, by definition, then you're not in the competition.

I'm wondering—Dr. Trivelpiece says, "Well, look, you can't provide world-class facilities, first-rate facilities, across the board. And if you focus only on getting the quality research, that should not be a concern. Your concern is whether you have them or don't have them, it doesn't matter where, and it doesn't matter that others are not players at that point in the process." That's putting some words in your mouth and I apologize for that—and those are my words and not yours. But the idea is that you just can't—you don't have the resources to have these facilities widely distributed.

To the degree that this kind of a program could be focused on specific areas, to the degree it was in the interest of the Federal agency to focus on specific areas, it may be that this program should be focused on national centers or on centers whose purpose was—whose purpose included giving access to a wide range of institutions. And if Cornell got a center, it may be that integral in that application would be that Cornell had a proposal which gave access to Utica College to that facility, and instead of just approving passively proposals for certain research, we ought to be creating, in a sense, distributional centers where the research might be only in one place but where there was a specific plan that involved making that facility available for a regional range of institutions.

Any reaction to that thought?

Dr. **Bentley**. May I just respond quickly to this by an illustration. We have recently gone into a joint arrangement with the University of California at Berkeley on a gene—genetic expression lab or gene expression laboratory in the plant sciences. And we have made—and we have a facility at Presidio in the Western Regional Research Lab. We have dedicated a portion of that laboratory to this particular problem in joint effort with the university laboratory because it's just across the road, so to speak.

We have, as a part of that, is that that facility or that center will be available to other universities, and the number of universities that wish to work in this area can apply for space to work there, can talk about not necessarily funding but they can talk in a cooperative basis. We think that this is a very important thing to do, and I think where it's possible within agriculture we're going to do as much of that as we can in the years ahead. We already have cooperative programs where we think there's an opportunity to expand, and that's one specific illustration.

We have some work going at Georgia. I think we have some plans at Cornell in the future as well, where we have actually in juxtaposition we have facilities at a university where we can work together, and we would like to stress the regional concept.

Mr. **Walgren**. Yes; I'm sure that you—I mean, the idea is obvious enough that people have been down that road.

Dr. Trivelpiece.

Dr. **Trivelpiece**. In fact, what you described is more or less the way a good fraction of the Department of Energy does its business. Things like the National Synchotron Light Source which is at Brookhaven is used on a 40 percent basis by academic institutions, that you go there and there are representatives doing—from institutions all over the United States. I forget the exact number, but I think it's somewhere around 600 or 700 university users—600 or 700 universities take advantage of DOE's facilities all over the country in just the manner you described. And those facilities are usually put in place with them in mind and their participation at the outset. And the funding goes to the academic institution to build the instrumentation.

Mr. **Walgren**. But that's clearly a national laboratory, Brookhaven; is that right?

Dr. **Trivelpiece**. Yes; but then there are also such facilities at academic institutions as well—Notre Dame, Princeton—I can recite some but I don't remember all of them at the moment. There are some 50 of these user facilities located at different places around the United States.

If I could add to something else, something you haven't touched on here today—and I thought it probably would be one of the early themes—and that is, to some extent the dilemma that you find yourself in is the kind of pressure from constituents to put facilities in, and at the moment this has been happening in kind of an ad hoc way and various facilities have been added to appropriation bills here and there for different purposes.

That places the academic institutions in a dilemma because, although they would like to see a certain degree of merit review, peer review, applied, that they then find themselves under pressure from their own delegations or from the Governor of the State, to go and do the same thing that the others are doing. I'm sure you have experienced that pressure. So to some extent a program which has some funding feature built into it that permits competition within that area would relieve part of that pressure. I am very sympathetic to that need on the part of the Congress and the institutions in the United States. And the pressure is growing all the time, simply because the backlog of need for both bricks and mortar and scientific facilities is growing. The number of people who are smart and know what to do and how to do it and would like to do it and want to get in the game and compete in the research business are growing, and that is creating pressure for these kinds of facilities. The State resources are limited and the Federal resources are limited and it's created quite a dilemma. To that extent I am very sympathetic with what you're trying to do to find a way to release some of that pressure in a self-consistent, competitive way which does not affect the rest of the system.

Mr. **Walgren**. Dr. Wyngaarden?

Dr. **Wyngaarden**. Yes, Mr. Chairman, I would like to comment on some of these themes.

The points made about the national facilities in Energy and NASA have some common features with ours, but we are probably less dependent on those very large, expensive, centralized facilities in biological science than some other fields. We do have some. We have a million volt electron microscope, for example, in one place which is used by many scientists who go there.

We support work in about 1,250 institutions throughout the country, and they range from the large research-intensive university to small colleges or nonteaching hospitals and research institutes in various parts of the country.

I'm just wondering whether maybe we're trying to do too much with one piece of legislation. It seems to me that the primary theme of the university presidents and scientists who have come to see you deals with the facilities of the research-intensive university, on the argument that a great deal of the research is done there and that that materially affects our national competitiveness in science and industrial competitiveness in biotechnology and so on. That's not to say that a lot of good work isn't done in smaller places, but our primary need is probably in those large research-intensive universities.

We do have some other programs to deal with the minority institutions, to deal with the colleges. We have the Academic Research Enhancement Award [AREA] Program that the Congress has doubled next year, which is going well. And perhaps we ought to narrow the objective of this particular vehicle of legislation to address the one very large problem at this time.

Mr. **Walgren**. Well, I think that's a point well taken. A lot of our reactions are in frustration to the lack of progress in the other areas and the fact that our programs, although there are programs there, they certainly are falling behind the problem rather than gaining ground on the problem. I suppose it's instinctive not to want to make matters worse.

Well——

Mr. **Boehlert**. That's it.

Mr. **Walgren**. Well, thank you all very much for your presentations. We appreciate your resource—your being a resource to the committee and to the country. Thank you.

[Whereupon, at 5:15 p.m., the subcommittee was adjourned.]

APPENDIX

ADDITIONAL WRITTEN STATEMENTS FOR THE RECORD

The State of Graduate Education

Papers by BRUCE L. R. SMITH
ROBERT G. SNYDER
MICHAEL S. MCPHERSON
F. KARL WILLENBROCK
JAMES W. JOHNSON
LINDA S. WILSON
JOHN C. VAUGHN
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The Capital Facilities Dilemma in the American Graduate School

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UNIVERSITIES conduct more than half of the nation's fundamental research and about one-quarter of its total research. They are an integral part of the search for solutions to problems in national security, health care, energy, productivity, education, and the environment. They are the principal providers of the training of future generations of scientists, engineers, teachers, and professionals. The health and strength of these institutions are therefore matters of national interest.

The general state of the physical plant of America's higher education institutions has recently been diagnosed in dismal terms: "The halls of academe are crumbling. Buildings, grounds, and utilities . . . are in a dilapidated condition, endangering life and property. The vitality of the higher education enterprise is in jeopardy."[1] One-half of higher education's physical plant is more than twenty-five years old; one-quarter was built before World War II. The aging physical plant needs renewal, realignment, and replacement. The cost of needed renewal and replacement is estimated at a staggering $30 billion.[2] During the 1950s and 1960s the nation expanded its facilities for instruction and basic research. It failed, however, to provide adequately for their renewal and replacement.

The focus of this paper is on the universities' physical facilities for graduate education and research in science and engineering. Other aspects of higher education's infrastructure will be considered only as they share features or trends with the physical facilities for graduate education and research.

Several conditions create additional demands for renewal and

The author gratefully acknowledges the valuable assistance of Karen Arnold, Ph.D. candidate in higher education administration at the University of Illinois, and helpful discussions with many colleagues in government, universities and university associations, industry, and private foundations.

[1] Harvey H. Kaiser, *Crumbling Academe: Solving the Capital Renewal and Replacement Dilemma* (Washington, D.C.: Association of Governing Boards of Universities and Colleges, 1984), p. vi.

[2] Ibid., p. 13.

modernization of the universities' physical facilities. In the postindustrial, knowledge-based society, national imperatives for economic progress require enhanced investments in human capital and more effective communication of knowledge and technology. Acceleration of the rate of technical change and of international competition in science and technology places new emphasis on the role of graduate education and research. Emerging scientific and technological opportunities change the research and generate requirements for higher-quality laboratories. Work with smaller dimensions and greater measurement sensitivities requires cleaner environments, which are difficult to achieve in old facilities. Technical advances in instrumentation and communication technology profoundly affect methods of research, exchange of ideas, and patterns of work of scientists and engineers.

The role of facilities in graduate education and research

The prolonged period of fiscal constraint has taken a heavy toll on the capital assets of higher education. The magnitude of renewal costs strains the nation's capacity for response, especially when there are many pressing needs on the national agenda. As one considers the renewal problem one must first specify how outdated facilities affect the quality and productivity of graduate education and research. Some good work has been done in spite of abominable facilities. Excellent facilities cannot in themselves ensure high-quality graduate education and research.

Three principal features of the U.S. science support system are concentration of basic research in the universities, integration of advanced research and graduate instruction, and emphasis on support of research projects rather than support of institutions. The U.S. experiment with concentrating basic science research in its universities has facilitated a wide range of contacts among scholars, researchers, and students, and it has encouraged independent research at all levels.[3]

Integration of advanced research and graduate instruction is a hallmark of the U.S. system. It has encouraged students to participate in original research, in which they learn new and creative techniques, they learn to question, and they learn responsibility. It has also helped maintain the vitality of the research faculty.[4]

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3. Carnegie Foundation for the Advancement of Teaching, Carnegie Council on Policy Studies in Higher Education, *Three Thousand Futures: The Next Twenty Years for Higher Education* (San Francisco: Jossey-Bass, 1980), p. 112.

4. Wolfgang K. H. Panofsky, "Big Science and Graduate Education," in Harold Orlans, ed., *Science Policy and the University* (Brookings, 1968), pp. 192–93.

Integrating graduate education and research is considered effective, but it has not been rigorously tested. Because of formidable methodological obstacles, the cause-and-effect linkage will probably never be proved. International comparisons of scientific leadership and productivity, however, lend credibility to the view that this U.S. design is very advantageous.

The emphasis on project support in the U.S. science system has many advantages, but it has some disadvantages in ensuring adequate infrastructure for research. As the project system now operates, firm commitments of support are rarely given for longer than one year, and planned commitments are often given for only three years, rarely for more than five years. The system requires accountability by discrete project. Neither of these features ideally ensures adequate infrastructure. Both approaches encourage narrow focus and short-term effectiveness; infrastructure requirements are usually broad and long term.

Effects of facilities limitations

Empirical data on the relationship between the quantity and state of facilities on the one hand and graduate education and research on the other are limited. That there is a strong connection, however, seems obvious. The National Science Board's study on graduate education in 1969 identified the amount of physical plant available for graduate education as an important potential indicator of quality of graduate programs, but it acknowledged that insufficient information was available for satisfactory analysis.[5] None of the subsequent national assessments of quality of graduate programs, however, has used facilities other than library resources as an indicator of quality, presumably because of the difficulties in obtaining the necessary data. A more recent multinational study of the factors that affect scientific productivity in research groups suggested that there is a minimum threshold of necessary resources (including both funding and facilities). Above that threshold, productivity is related more to the researchers' perception of the reasonableness of the share of resources available to them than to the actual amount of resources available.[6]

A recent effort to develop a methodology for assessing basic research compared the scientific progress at the major high-energy physics laboratories in the world. This work clearly demonstrated the critical role played by the age and design of the accelerator facilities in the quality and effect of the work produced.[7] The influence of the physical environment on the learning process has been studied more than its influence on research and graduate education.[8] In the absence of further empirical evidence, one must draw on general wisdom to suggest ways in which the physical plant affects graduate education and research. The actual measurement of these effects is more difficult.

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[5] National Science Board, *Graduate Education—Parameters for Public Policy* (Government Printing Office, 1969).

[6] Frank M. Andrews, ed., *Scientific Productivity: The Effectiveness of Research Groups in Six Countries* (Cambridge University Press/UNESCO, 1979).

Since it influences most human endeavors, the notion of what is possible influences the development of research ideas and plans. Overcrowding, inflexibility of space, and inadequacy of environmental controls can stifle the imagination of students and faculty, especially if they perceive little or no opportunity for improvement. In the physical sciences there are reports of an increasing trend for graduate students to choose doctoral research in theoretical rather than experimental topics.[9] Several factors may be involved, including the intellectual attraction of theory; the availability of computer simulation as a substitute for experimentation; and the advances in equipment, which have increased the rate of progress in experimental research. The frustrations resulting from inadequate equipment and facilities may also be a significant and growing cause of the shift. The importance of well-trained experimentalists for industry suggests that more careful analysis of the trends is in order.

The ability to take advantage of new directions in research is also limited by facilities. Scientists specializing in the mechanisms of photosynthesis may recognize the potential for important applications through extension of their studies to aquatic plants. Without extensively modified facilities, however, they cannot pursue this line of investigation. The exploitation of the scientific opportunity depends on the availability of funds for realignment of laboratory space.

Limitations on facilities can also lead to conservative science. Those whose experimental efforts are limited to what can be accomplished at shared regional and national facilities worry that the processes used to determine access will discourage lines of inquiry that have a high payoff but are speculative.

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[7] Ben R. Martin and John Irvine, "CERN: Past Performance and Future Prospects," *Research Policy*, forthcoming; "Assessing Basic Research: Some Partial Indicators of Scientific Progress in Radio Astronomy," *Research Policy*, vol. 12 (April 1983), pp. 61–90.

[8] J. King and R. W. Marans, *The Physical Environment and the Learning Process: A Survey of Recent Research* (Ann Arbor: University of Michigan, Survey Research Center, Institute for Social Research, and Architectural Research Laboratory, College of Architecture and Urban Planning, for UNESCO, 1979).

[9] William A. Fowler, Testimony before the House Subcommittee on Science, Research, and Technology, 97 Cong. 2 sess., March 4, 1982, in *Revitalizing Laboratory Instrumentation* (Washington, D.C.: National Academy Press, 1983), appendix C, pp. 68–69; personal communication from Herman Fishbach, Massachusetts Institute of Technology.

Although there have been efforts to ascertain what specific research problems are not being addressed because of limitations in equipment or facilities, the attempts have not been extensive or systematic.[10] The evidence is largely anecdotal. The difficulty of the judgments at issue hampers the design of methods to assess the effect of stifling research. The more creative the ideas, the less predictable they would be and the less noticeable their absence would be in the short term. More thorough methods for assessing the effects of facilities on the choice of research problems are needed if we are to act with confidence in investing scarce resources in facilities or in denying such investments.

The degree of collaboration and interaction among scientists and students is affected by physical facilities. Close proximity of personnel is important for effective scientific communication. The sharing of instrumentation and laboratory facilities can stimulate and facilitate the development of collaborative scientific efforts. The growing need to share major research instrumentation may encourage the development of new disciplines at the interfaces of traditional disciplines.

When individual research groups are dispersed because contiguous space is not available, interaction is reduced, and the quality of research supervision and training may be undermined as well. The new communications technologies may overcome some of these difficulties, but face-to-face interaction still plays a key role in the stimulation and development of ideas among scientists. Face-to-face interaction is perhaps even more important for the socialization of students within their professions.[11]

Physical facilities also affect university responsiveness to regional and national interest in the transfer of knowledge and technology to industry. University-industry cooperative research in many cases represents an expansion, or at least a shift in emphasis, in the universities' scope of activities. Much of the university-industry cooperative work will require additional facilities or at least modification of existing space. This is especially true for the cooperative efforts designed to respond to the needs of new high-technology enterprises and other small businesses. Few of these organizations have their own internal research facilities. They must, therefore, rely on university facilities to house collaboration. Cooperative research arrangements may be of short duration, so the design of the research facilities must remain flexible.

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[10] Association of American Universities, *The Nation's Deteriorating University Research Facilities* (Washington, D.C.: AAU, 1981).

[11] A. W. Chickering, ed., *The Modern American College* (San Francisco: Jossey-Bass, 1981).

Perhaps the most serious effect of inadequate facilities is on the recruiting and retention of the most productive faculty members. The erosion of academic facilities is seriously limiting the attractiveness of the academic profession for some of the best and brightest of both new and senior scientists. Failure to overcome such disincentives will seriously affect the universities' role as a major research performer and as the primary provider of advanced training.

Clearly, research facilities have an effect on the validity of research results. Inadequacies in environmental control limit the quality of data. Crowding limits the access to research facilities and reduces the number of experiments that are undertaken. Physical deterioration and overload lead to downtime, which seriously affects productivity. A recent survey of a sample of NSF-funded investigators found that 60 percent reported having lost some time in the past year because of facilities-related failures.[12] Scientific areas that rely on computerized data acquisition require air conditioning. Inadequate provision for air conditioning yields downtime on the order of 50 percent during the summer months in some parts of the country. Deferred maintenance and aging of buildings cause leaks, which ruin instrumentation and experiments and cause extended interruptions in work. Probably all professionals lose some time every year to facility-related difficulties. The issues are the severity and duration of such difficulties and the cost imposed by them.

Old buildings accommodate current scientific purposes with difficulty. Their systems for distributing utilities and services cannot satisfy current scientific demands. Their construction is rarely adequate for experiments that are sensitive to vibration or that demand a dust-free environment. They have only limited flexibility for rearrangement to locate related groups of scientists near each other. Productivity diminishes as students and faculty spend time traveling among laboratories and gaining access to needed instrumentation.

The ability of each graduate student to develop as an independent investigator is affected by the facilities and the instrumentation available. The development of team approaches for complex problems and the need to share major instrumentation limit independent work. The ability of the physical plant to accommodate state-of-the-art instrumentation profoundly affects the training of graduate students. Deteriorating physical plants and obsolete equipment have already put many programs, especially in engineering, far behind current professional practice. To the extent that universities lag rather than lead in state-of-the-art practice, they do not meet the needs of industry and government for highly trained personnel.

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[12] National Science Foundation, Division of Policy Research and Analysis, "University Research Facilities: Report on a Survey among National Science Foundation Grantees," in *Discussion Issues 1984, Academic Science and Engineering: Physical Infrastructure*, vol. 2: *Background Material*, section C (Washington, D.C.: GPO, 1984).

Limitations in instrumentation and physical facilities also affect the extent to which undergraduates are able to participate in research. In some institutions space more than anything else limits undergraduate participation in research.[13] If this problem spreads, it will impair the recruitment of undergraduates into graduate study and the quality of their preparation for graduate study.

The inability to take all the precautions needed to ensure safety in the laboratory and to comply with environmental standards is a matter of growing concern. As the frontiers of science have advanced, new potential hazards have emerged and must be addressed. Difficult compromises must be made when resources are not available to make the necessary major renovations in old buildings. Safety education, extraordinary laboratory "housekeeping," and careful segregation of risks can only partially compensate for inadequacies in facilities design. The long-term loss in productivity and the cost of such compromises indicate the need for more fundamental solutions.

The openness of the facilities and the involvement of all levels of students in the university setting intensify the need for careful attention to safety. Universities also have a responsibility to train the next generation of scientists in safe practices. The nature and use of university laboratories, however, require different safety standards and management from those designed for industrial plants. Application of regulations that ignore or overlook these differences can cause an unnecessary drain on scarce resources for facilities renewal.

Specific examples of the consequences of deficiencies in facilities include diminished international competitiveness of U.S. industry, especially with European industry and Japanese industry; diminished knowledge for the development of new processes and products; decelerating innovation and delay in achievement of national objectives; and inability to provide critical technical assistance in emergencies.[14] The capacity for renewal and replacement of capital assets is essential for any enterprise. For science, the essence of which is change, the consequences of failure to ensure capital renewal and replacement may be especially severe.

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[13] Personal communications from Jiri Jonas, Samuel Kaplan, and Emanuel Donchin, University of Illinois.

Evolution of the research facilities problem

A recent background paper developed for the National Science Board's discussion of physical structure problems in academic science and engineering summarized the evolution of the research facilities problem.[15] The sources of support for the physical plant of America's research universities have changed over the past century. Before World War II most support for facilities and equipment for academic science came from the private sector (including industry), from state appropriations, and in some areas from federal land grants and formula appropriations. After World War II the federal government was the major source of support for academic research programs, but not for facilities. The period from 1950 to 1970 saw a boom in construction of instructional facilities and housing to accommodate a rapid expansion of enrollments. At the same time the demand for research space increased because of expansion of faculty and because of changes in faculty workloads. The demands for resources to expand exceeded the capacity of philanthropic organizations and industry to respond. The successful Soviet orbiting of Sputnik stimulated federal support. The government saw that facilities construction was needed to ensure the nation's research capacity.

The peak of the science facilities construction boom occurred in the early 1960s. At that time the federal contribution to construction of academic R&D facilities was about 35 percent of the total. The balance was met by state governments, endowments, philanthropic and corporate contributions, and special building fundraising drives. By the early 1970s the rapid growth in academia began to subside. Federal programs to stimulate expansion of research and training capacity were phased down; most, in fact, were eliminated. Today almost no federal programs fund academic research facilities other than those that house very specialized research instrumentation, such as accelerators. Table 1 describes the various federal facility programs.

University budgeting and planning for facilities have encoun-

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[14] Association of American Universities. *Nation's Deteriorating University Research Facilities*, p. 4 and appendixes.

[15] National Science Foundation, "University Research Facilities," in *Discussion Issues 1984*, vol. 1: *Issues and Options*, pp. 1–2.

Table 1. *Federal Facility Funding Programs*

Date	*Funding source*	*Purpose*	*Amount of funding*
1948–50	National Cancer Institute 1948 Construction Authority	Cancer research facilities construction	$16.3 million
1950	National Heart Act	Heart disease research facilities construction	$6.059 million
1956–68	Health Research Facilities Act of 1956	Nonfederal health sciences research facilities construction	$438.76 million
1956–70	Academic Computational Facilities and Operations Program, National Science Foundation (NSF)	Purchase, rental, and operation of electronic computers and related equipment for university and college science programs	$71.2 million to 184 institutions
1959	Ford Foundation Special ("Challenge") Program in Education	Development of selected institutions to become regional and national centers of excellence	$349 million; total grants and matching funds: $1.3 billion
1960–70	Graduate Science Facilities Program (NSF)	University laboratory space construction and general purpose equipment for such space	$188.16 million to 977 grantees
1960–62	National Heart Institute Primate Research Center Program	Primate research center facilities construction	$9.396 million
1961–72	Institutional Grants for Science (NSF)	Sustaining and improving academic science in existing high-quality institutions	$120 million to 939 institutions
1961–72	Interdisciplinary Laboratories for Materials Research (Advanced Research Projects Agency of Department of Defense; transferred to NSF in 1972)	Development of manpower and interdisciplinary approaches to materials research problems; construction of major central research facilities	$158 million (currently funded by NSF at $13.9 million a year)
1962–71	Sustaining University Programs, National Aeronautics and Space Administration (NASA)	Graduate training in space-related sciences, including facilities construction	$224.8 million
1963–65	Higher Education Facilities Act of 1963 (Office of Education)	Undergraduate and graduate academic facilities construction, reconstruction, and renovation; wider distribution of graduate schools	Not available
1963–	Health Manpower Training Facilities Program, National Institutes of Health (NIH)	Teaching and multipurpose facilities construction for health profession students	Not available
1964–67	Mental Retardation Facilities and Community Mental Health Centers Construction Act of 1964	Facilities construction for research on mental retardation	$65.561 million
1964–72	University and Department Science Development Programs (NSF)	Broad-scale program development to upgrade science and engineering research	$22.3 million to 140 institutions

Table 1. *Federal Facility Funding Programs (continued)*

Date	*Funding source*	*Purpose*	*Amount of funding*
1965–	Higher Education Act of 1965	Continued facilities construction authority of Higher Education Act of 1963	Construction grants unfunded 1981–84; $28 million in 1985
1967–71	Project THEMIS, Department of Defense (DOD)	Enhancement of academic capacity in science and technology; encouragement of increased numbers of institutions engaged in high-quality research; wider geographical distribution of research funds	$94.49 million
1971–83	National Cancer Act of 1971	Cancer research facilities construction	$236.483 million
1972	National Heart, Blood Vessel, Lung, and Blood Act of 1972	Hospital, clinic, and laboratory facilities construction	No funds appropriated under this authority
1978–	Health Services Research and Health Care Technology Act	Public and nonprofit vision research facilities construction	$5 million
1981	National Agricultural Research, Extension, and Teaching Policy Act	Acquisition and improvement of research facilities in 1890 Land Grant institutions	Not available
Proposed	Construction of Animal Facilities Authority (Division of Research Resources, NIH)	Replacement of outmoded animal research facilities; improvement of existing NIH programs	Requested: $40 million for fiscal 1985
Proposed	Research Facilities Rehabilitation Program (DOD)	Upgrading or replacement of selected university laboratories performing research essential to DOD's long-term mission	Requested: $100 million for fiscal 1985

tered a series of difficulties. During the 1960s and early 1970s expansion efforts strained the budgets and planning capacities of the universities. Then several major changes intensified the difficulties: inflation, government regulation, technological advance, and sources and terms of financing.[16] At the same time research facilities obsolesced as the frontiers of science and technology advanced. The structure of the U.S. academic science support system, by focusing principally on short-term, individual transactions, has obscured the broader needs of the research system as a whole. The universities have not been able to compensate for this flaw.

The magnitude of the problem

How serious is the facilities problem? What trends need to be taken into account? What are the responsibilities of the various actors in the process? Table 2 summarizes the major published

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[16] Lawrence L. Landry and Rodney Mebane, "Capital Crisis in Higher Education," *Business Officer*, February 1982, pp. 20–22.

Table 2. *Studies of Academic Facilities*

Study	*Description of study*	*Findings*
"Health Related Research Facilities in the U.S. in the Nonprofit Nonfederal Sector," conducted by Westat Corporation for National Institutes of Health (NIH), 1969	Survey gathered data on the amount, age, and ownership of space in 1968; the amount of space under or scheduled for construction; and the estimated space needed to eliminate overcrowding by 1980	—10 million of 42 million square feet in unsatisfactory condition —Over 50 percent available space in poor condition —Additional 55 million square feet of space needed by 1980, with 17 million square feet requiring remodeling
"Higher Education General Information Survey" (HEGIS), conducted by the National Center for Education Statistics (NCES), 1974	Survey of 3,200 colleges and universities, including data to estimate facilities needs	—20 percent of facilities at surveyed institutions in need of replacement (2.3 billion square feet) —$2 billion needed just for remodeling of facilities
"Health Research Facilities: A Survey of Doctorate-Granting Institutions," conducted by the American Council on Education (ACE) with funding from the National Science Foundation (NSF) and NIH, 1976	Survey of 155 Ph.D.-granting institutions gathered data on status of academic health research facilities, new construction in progress, and plans for expansion in succeeding five-year period	—29 percent of academic facilities for health research in need of renovation or replacement (23 million square feet) —Cost estimates to meet needs: $547 million for 1975, $560 million for each of succeeding five years
"National Survey of Laboratory Animal Facilities and Resources," conducted by the National Academy of Sciences (NAS), NIH Publication 80-2091 (1978)	Survey of 922 nonprofit NIH-eligible institutions gathered data to estimate facilities needs	—16 percent of institutions reported need for replacement of facilities —38 percent reported need for remodeling of facilities —47 percent reported need for additional space
Report of Research Facilities Branch of National Cancer Institute on survey of facilities needs in cancer research, conducted at request of National Cancer Advisory Board, 1979	Survey of 106 institutions receiving National Cancer Institute support gathered data to evaluate current and future needs to upgrade cancer research facilities	—$149 million for 1980–85 estimated for cancer research facilities
"A Program for Renewed Partnership," prepared by the Sloan Commission on Higher Education, 1980	Commission report on federal government–university relations (no data collected)	—Recommendations for competitive program for facilities research grants: $50 million annually for five years, to be allocated by NSF and NIH, to upgrade research laboratories and equipment
"The Nation's Deteriorating Research Facilities: A Survey of Recent Expenditures and Projected Needs in Fifteen Universities," conducted by the Association of American Universities (AAU), 1981	Survey of 15 leading universities gathered data on expenditures for research facilities and major equipment and estimates of funding needs for faculty research only for succeeding three-year period	—Surveyed institutions spent $400 million for facilities construction, repair, and renovation in 1972–82 —$765 million needed for facilities and equipment over succeeding three-year period just to sustain faculty research activities

Table 2. *Studies of Academic Facilities (continued)*

Study	*Description of study*	*Findings*
Report on academic facilities survey (in 1980–81 Comparative Cost and Staffing Report), conducted by the Association of Physical Plant Administrators (APPA), 1981	Survey of 226 institutions with 454 million square feet of academic space gathered data on facilities conditions and projected needs	—$1.85–$2.00 per square foot required to eliminate most pressing needs —Deferred maintenance need per institution of $9.5 million at universities, $1.1 million at four-year colleges, $0.4 million at two-year colleges
"Strengthening the Government-University Partnership in Science," conducted by the Ad Hoc Committee of NAS, National Academy of Engineering and Institute of Medicine, 1983	Committee report on federal government–university relations (no data gathered)	—Critical, growing need for replacement of academic science facilities and equipment —Recommended comprehensive program for facilities construction and for development, acquisition, maintenance, and operation of modern equipment
Report of Department of Defense (DOD) Working Group on Engineering and Science Education, prepared by the DOD-University Forum, 1983	Working group report on condition and needs of academic science and engineering	—Deficiencies in research facilities and equipment acute in most universities
"Report on NIH Experience with Extramural Construction Authority," prepared by the Office of Program Planning and Evaluation, NIH, 1983	Historical comparison of legislative authorities for construction of health research facilities analyzing past facilities funding experiences	—Funding authorities mainly for special, not general, use —Almost all funds made available under grant mechanisms —Recent authorities fail to separate funds for construction and research —None of funding authorities based on systematic analysis of need
"Adequacy of Academic Research Facilities," conducted by the Ad Hoc Interagency Steering Committee on Academic Research Facilities, NSF, April 1984	Pilot study of 25 major research institutions, with major study planned to gather data for detailed analysis of the condition of facilities used for science and engineering and medical research. Estimated future needs for construction, remodeling, and refurbishment of academic research facilities	—Over succeeding five-year period all colleges and universities require about $1.3 billion a year for research facilities alone (Note: Present level of capital facilities expenditures for academic research, development, *and* instruction is $1 billion a year)
"University Research Facilities: Report on a Survey Among National Science Foundation Grantees," conducted by the Division of Policy Research and Analysis, NSF, for Infrastructure Task Group of National Science Board (NSB), June 1984	Survey of 1983 NSF grant for principal investigators (248 randomly sampled) to determine condition of existing facilities and impact of facilities on research	—70 percent of facilities had been renovated in last ten years using 7 percent federal dollars —50 percent of facilities slated for renovation in next three years —80 percent of PIs rated safety of facilities as excellent

Table 2. *Studies of Academic Facilities (continued)*

Study	*Description of study*	*Findings*
		—40 percent of PIs reported having lost some research time in past year because of facilities-related failures; 40 percent reported graduate students had spent three or more days fixing problems created by facilities over past year
Proposed study of cancer research facilities, conducted by the President's Cancer Panel and the National Cancer Institute	Proposed survey study to gather data to inventory the quality and quantity of current research facilities in cancer research	In progress
Study of facilities needs in chemical science and engineering, conducted under the aegis of the Board on Chemical Science and Technology, National Research Council (in progress)	Survey to ascertain specific facilities data for research and teaching in chemistry, biochemistry, and chemical engineering academic departments	In progress

studies that address facilities problems from 1969 to 1984. The definitions, assumptions, and criteria for recommending replacement or remodeling vary among reports. While the studies support an overall conclusion that renewal and replacement of facilities are needed, they leave unanswered some questions that are important in the design of effective remedial action.

To assess the magnitude of the need, past expenditure levels and current short-range plans can be compared with available funding. Using this approach, a recent preliminary analysis revealed the following picture. The current level of capital facilities expenditures for academic research, development, and instruction is roughly $1 billion a year. The federal government contributes approximately 15 percent of this amount. (Similarly, federal obligations for capital expenditures for federally funded research and development centers run about 15 percent of their total R&D expenditures.) The universities' level of capital expenditure for science and engineering was relatively constant during 1968–81 in current dollars, but decreased 60 percent in constant dollars. The federal share of that amount declined by a factor of two over that period. Federal obligations to universities for R&D plant peaked in the 1960s, declined sharply until 1973, and remained relatively constant in current dollars between 1973 and 1983. In constant dollars, however, from 1966 to 1983 federal obligations to universities for R&D plant decreased by 90 percent.[17] Universities' planned academic capital expenditures for R&D facilities (excluding instruction) are estimated at approximately $1.3 billion annually from 1983 to 1988, an expenditure rate approximately double that of the past five years.[18]

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[17] National Science Foundation, "University Research Facilities," in *Discussion Issues 1984*, vol. 1: *Issues and Options*, pp. 5–7.

Past expenditure levels and current plans for the future are inadequate as measures of the need for future expenditures. Institutional plans are heavily guided by pragmatic assessments of the amount of capital funds expected from public and private sources. Recently, such plans have grossly underestimated actual need.[19] Furthermore, the institutions' objectives may or may not coincide with national objectives. To address the differences between these objectives, data must be disaggregated to distinguish between fields of science and to distinguish research and graduate education from all academic science.

Another approach to assessing need is to consider the total area of the academic R&D physical plant, the age of the facilities, the cost of replacing existing facilities, and the cost of renovation as a fraction of replacement cost. Estimates of the frequency of need for renovation as well as the relative costs of various types of space permit development of rough guidelines for determining the need for capital funds. Based on the 1974 Higher Education General Information Survey of all facilities in institutions of higher education, and projection to 1981 levels, for example, the total replacement value for buildings was estimated at $143 billion and building renewal and remodeling needs were projected at $30 billion. For an average university, the combined renewal and replacement needs were estimated at $70.4 million.[20] (For a research university the needs would obviously be much higher, perhaps three or four times higher.) Note that current capital requirements are roughly similar to the total expenditures of all higher education in one year; they are at least three times the current value of all college and university endowments in the United States.

The Interagency Steering Committee on Academic Research Facilities has planned to study academic research facilities in depth. This study will survey the amount of R&D space in use; the condition of the space; the additional construction, modernization, and repair required to carry out innovative research; and institutional and disciplinary perceptions of the priorities for future needs in facilities. The survey will also address past and future funding for facilities, the cost of the R&D, and the number of persons using the space.[21]

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[18] Ibid.

[19] Personal communications from Steve Rugg, Anthony Graziano, and Harlan Bareither, University of Illinois, and Barbara Hansen, University of Southern Illinois.

[20] National Center for Education Statistics, *Inventory of Facilities in Higher Education* (Washington, D.C.: GPO, 1974).

A third approach to assessing need is to develop estimates of the capitalization required per researcher, as was done in the Snowbird Report on the Computing Resource Needs of Faculty in Computer Science.[22] Unfortunately, the NSF data on capital expenditures for academic R&D do not distinguish between facilities expenditures and equipment expenditures.[23] Furthermore, the capitalization requirements may be far more difficult to determine in fields that use a broader array of equipment and facilities than is required in computer science.

All efforts to assess the magnitude of the academic R&D facilities problem are complicated by the absence of a common definition of need. Need may be defined as it affects the capacity to respond to specific national objectives, as it affects each institution's own interests, and as it affects the orderly development of science. Although these three aspects of need are related, they do not coincide. Common standards for determining the level and the urgency of the need are missing. Within the broad categories of "compelling need" and "calculated risk," the institutions establish priorities based on the need to protect occupants, buildings, built-in equipment, and other facilities, in that order. Once these needs are met, programmatic concerns can be addressed.[24]

Those who support academic R&D require information that will permit choices among competing claims. They need information on the potential of emerging scientific opportunities. A study of recent experience with strategic research forecasting in France, in West Germany, in Japan, and in the United States concluded that governments or research funding agencies will have little success in predicting radical breakthroughs generated by basic research. Longer-term forecasting activities in emerging areas of strategic research, however, can be helpful, especially if the forecasting of government, funding agencies, and industry can be integrated.[25]

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[21] Personal communication from Carlos Kruytbosch, National Science Foundation.

[22] Peter J. Denning and others, "The Snowbird Report: A Discipline in Crisis," *Communications of the Association for Computing Machinery*, vol. 24 (June 1981), pp. 370–74.

[23] National Science Foundation, "Federal Support to Universities, Colleges, and Selected Non-Profit Institutions, *Fiscal Year 1982*," Surveys of Science Resources Series (Washington, D.C.: GPO, 1984), pp. 84–315.

[24] Kaiser, *Crumbling Academe*, p. 24.

[25] John Irvine and Ben R. Martin, *Foresight in Science: Picking the Winners* (London and Dover, N.H.: Frances Pinter, 1984), p. 150.

The needs for equipment and facilities in the leading research universities (identified on the basis of their level of R&D expenditures) differ from those in other graduate higher education institutions. The institutions themselves differ in the extent of research activities, in the emphasis on doctoral studies, in the emphasis on particular disciplines, and in size.[26] The leading research universities on the average conducted 20 times as much sponsored research as other graduate institutions and 1,000 times as much as was conducted by all other institutions. These differences vary by field. The leading research universities enroll at least five times as many graduate students as other graduate institutions, they grant twelve times as many doctoral degrees, and they are more than twice as large in overall enrollment. Public research universities enroll almost twice as many students as the leading private research universities.

The facilities renewal problem is large, it is complex, and its consequences will vary in time and among scientific fields. Concerted efforts are needed to arrest the decay and to enable the facilities to take advantage of technological opportunities. The problem must be delineated so that the most critical needs can be addressed first.

Renewal of capital facilities, of course, is not the only financial issue. Aged, worn-out, and obsolescent equipment is also a very serious problem; table 3 summarizes some recent reports on the nature and extent of the equipment problem. Faculty salaries need upgrading to rectify a 20 percent loss in purchasing power over the last decade.[27] In fields subject to high demand, efforts to recruit and to maintain faculty are straining both institutional budgets and collegial relationships.[28] Financial support for graduate students is still a significant problem, especially as demographic changes occur and as the competition for highly talented students increases within academia and between industry and academia.

Future developments that will influence institutional needs for facilities include the projected enrollment declines, demographic

26. Marilyn McCoy, Jack Krackower, and David Makowski, *Financing at the Leading 100 Research Universities: An Executive Overview* (Boulder, Colo.: National Center for Higher Education Management Systems, 1981).

27. Richard E. Anderson, "Higher Education in the 1970's: Preliminary Technical Report for Participating Institutions" (New York: Columbia University, Teachers College, Institute of Higher Education, 1983), reported in Ann E. Austin and Zelda F. Gamson, *Academic Workplace: New Demands, Heightened Tension*, ASHE-ERIC Higher Education Research Report 10 (Washington, D.C.: Association for the Study of Higher Education, 1983).

28. William Prokasy, "The Dilemma Colleges Face on Pay Scales," *Chronicle of Higher Education*, vol. 29, no. 7 (1984), p. 80.

Table 3. *Studies of Academic Research Instrumentation*

Study	*Description of study*	*Findings*
"Survey of Research Equipment Needs in Ten Academic Disciplines," conducted by the National Academy of Science, 1971	Survey of 8 science and engineering departments in 10 major disciplines to evaluate equipment needs of research universities	—Identifies deteriorating research equipment situation and estimates need to be "well over $200 million" —Recommends ongoing effort to monitor and assess instrumentation needs
"Research Equipment Assistance Programs: A National Science Foundation Research Management Improvement Project Research Report," prepared by Iowa State University, 1976	Report of project to develop cost-effective rapid response system for faculty sharing of scientific equipment	—Describes model for equipment sharing
"Equipment Needs and Utilization," prepared by Task Group of the NSF Advisory Council, 1978	Report of task group documenting research equipment needs and discussing role of federal funding in alleviating instrumentation needs	Descriptive report
"Report of the 1979 Instrumentation Subcommittee of the Department of Energy (DOE)/NSF Nuclear Science Advisory Committee," prepared by DOE/NSF Nuclear Science Advisory Committee, 1979	Committee report evaluating status of instrumentation in nuclear science, including current use of instrumentation, identification of state-of-the-art equipment, and determination of future needs	—Identifies serious problem in present instrumentation resources in nuclear physics
"Shared Use of Scientific Equipment at Colleges and Universities," Higher Education Panel Report #44, American Council on Education (ACE), 1979	Survey of 676 institutions gathering data on formal and informal procedures of universities and colleges to facilitate sharing scientific equipment	—Over 25 percent of surveyed institutions had systems to facilitate equipment sharing —An additional 18 percent of institutions planned such programs
"Expenditures for Scientific Research Equipment at Ph.D. Granting Institutions, FY 1978," Higher Education Panel Report #47, ACE (1980)	Survey of Ph.D.-granting institutions gathering data on level of institutional expenditures on research equipment, federal contribution to equipment, and the share of funds spent on high-cost items	—$280 million used for research equipment in fiscal 1978 at surveyed institutions —50 percent of funds for life sciences, 19 percent for engineering, and 16 percent for physical sciences equipment —65 percent of cost met with federal funding —9 percent of equipment cost over $50,000
"Studies of U.S. Universities' Research Equipment Needs Inclusive," prepared by the General Accounting Office, 1984	Literature review and analysis of completed studies on equipment needs in academic research	—Current studies cannot be used to determine equipment needs and are not comparable —Westat study (in progress) will provide more data but lacks thorough development of need indicators

Table 3. *Studies of Academic Research Instrumentation (continued)*

Study	*Description of study*	*Findings*
"Instrumentation Needs of Academic Departments of Chemistry," conducted by the American Chemical Society, 1984	Survey of major chemistry and chemical engineering departments to determine state of instrumentation and needs for instrumentation in university and college chemistry and chemical engineering programs	—Average age of instruments between eight and nine years —Needs of smaller and major institutions vary —15 percent of instruments not fully operational at smaller institutions, 9 percent at major institutions
"The Nationwide Study of University Research Equipment," currently being conducted by the Westat Corporation for NSF, as mandated in P.L. 96–44 (to be completed in 1985)	Three-year survey of 43 institutions in 4 science and engineering disciplines to develop statistically reliable indicators of need for major research equipment and to document trends in instrumentation cost, use, and condition	In progress

change, the increasing demand for part-time and continuing professional education, and maturation of the renewed relationship between industry and universities. The institutions heavily involved in federally sponsored research will probably be shielded from major enrollment declines, but some of them, especially those in metropolitan areas and within easy reach of high-technology industries, will experience an increase in the demand for part-time and nondegree instruction. Aggregate projections of these variables cannot be easily translated into forecasts for facilities.

Roles of the various sectors in graduate education support

Multiple factors determine how well the state and federal governments and the universities themselves will respond to the capital needs for graduate education and research. Is there any consensus about the roles various sectors will play in providing support, particularly support for facilities?

Constitutionally and historically, the states have had primary responsibility for public higher education.[29] The federal government has supported basic research and has augmented other sources of support for higher education to ensure that national needs are met. The federal government played an important role in development of the national capacity for research and graduate education after World War II. The state and federal roles, however, have never been articulated, and coordination has been limited. The argument for, and the design of, a national policy for graduate education was well stated in the National Science Board's 1969 report,[30] but subsequent decisions to provide federal support to individuals, not to institutions, aborted its implementation. The consequences of the lack of coordination of federal and state roles become all too clear as the expansion of higher education ends and fiscal pressures persist.

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[29] Lawrence E. Gladieux and Janet S. Hansen with Charles R. Byce, *The Federal Government, the States, and Higher Education: Issues for the 1980's* (New York: College Entrance Examination Board, 1981); Task Force on Graduate Education, *The States and Graduate Education*, Report 59 (Denver: Education Commission of the States, 1975).

The response of state governments to the physical facility problems will depend partly on the projections for undergraduate enrollments and partly on how much the states accept the responsibility to ensure the continuing development of disciplines of study at the graduate level. The Carnegie Council has projected undergraduate enrollment trends into the 1990s[31] and analyzed the variations by state. In the East and the Midwest, enrollment will decrease by about 10 percent. In the South it will increase by about 5 percent and in the Southwest by about 10 percent. Competing needs in the states, the general economic climate, and the nature of the institutions (public or private) will determine whether reduced enrollment permits improvements in quality of resources per student or triggers retrenchment. Careful analysis of higher education financing in the fifty states may permit more specific conclusions about the capacity of states to respond.[32] For both the federal and state governments, a key factor will be whether graduate students and university research programs are required to meet state and federal objectives and responsibilities. The increasingly close relationship of research and advanced training to the economic development of the states and of the nation as a whole will certainly have an important influence.

The universities' ability to allocate any of their operating budget to capital renewal costs will influence the capacity of the higher education institutions themselves to place higher priority on addressing capital needs. For many public institutions state governments determine the apportionment between capital and operating costs. Even when universities have the flexibility to make such choices, the problems of reallocation from operating support to capital support are extremely severe, without major increases in the total funding of the institutions. For one major university, for example, the cost of major remodeling and renovation needs approaches $30 million a year. This amount equals about 10 percent of the salary base.

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[30] National Science Board, *Toward a Public Policy for Graduate Education in the Sciences* (GPO, 1969).

[31] Carnegie Council, *Three Thousand Futures*, p. 66.

[32] Marilyn McCoy and D. Kent Halstead, *Higher Education Financing in Fifty States: Interstate Comparisons, Fiscal Year 1981* (Boulder, Colo.: National Center for Higher Education Management Systems and National Institute of Education, 1984).

The capacity of universities to respond will also depend on their planning and management. They need comprehensive audits of the condition of their physical facilities and effective mechanisms for setting priorities for the assignment of space and the selection of renovation and renewal projects.

Broad strategies

The facilities renewal problem can be addressed by three primary strategies: by assessing user charges, by increasing the investment in capital renewal and replacement, and by modifying or redefining need.

The responsibility for facilities costs could be realigned to provide a more realistic capital recovery mechanism. Most institutions currently assess the cost of facilities used in sponsored projects through a use charge built into the indirect cost rate. The use charge is limited to 2 percent of the original building cost, and it substantially underestimates the cost of providing adequate facilities. The cost of interest on money borrowed by institutions for acquisition, for major reconstruction, or for remodeling of buildings only recently became an allowable cost in federally sponsored agreements with educational institutions. More realistic charges for external use of university research facilities could be assessed as an indirect cost, or some more direct charging mechanism (such as rent) could be developed. The cost recovery could be handled on a project-by-project basis or on an aggregate basis. Combining capital recovery mechanisms with the existing project-support system could produce a system of cost allocations that is both proportional to use and responsive to scientific merit and priority decisions. Full application of systems of user charges will probably increase the cost to sponsors, including the federal government, for research undertaken by universities, but it would better reflect reality.

Adjustments in tax policy and legislative authority are strategies that might increase investment in facilities by increasing the capacity of the various sectors to respond to academic needs. The health of institutions of higher learning, public as well as private, depends on their ability to attract private support. The level of private support is quite sensitive to changes in tax policy such as changes in the marginal tax rate and limits on deductions of charitable contributions and of gifts of appreciated property.

Economic studies of the sensitivity of charitable giving to its price suggest that charitable giving decreases between 1.2 and 1.3 percent for every 1 percent increase in its price.

The predominant form of individual giving to colleges and universities for capital purposes is appreciated property, which composes 60 percent of individual gifts for capital purposes and 40 percent of all gifts.[33] The Economic Recovery Tax Act of 1981 permits investment tax credits that may be useful in designing support for capital renewal projects, but proposals for tax reform include disincentives for charitable giving. Any foreseeable benefits of an improved economic picture will not outweigh these disincentives.[34] The tax reform proposals are a matter of concern because of the significant role that private giving has played in capital support of universities.

Federal legislative authority for programs to finance science and engineering facilities is limited at this time. Almost all the federal programs that helped finance the building of U.S. academic research capacity have been eliminated and not replaced (see table 1). This constriction is partially responsible for the recent intensive lobbying efforts of some individual institutions, which have resulted in congressional authorization or appropriation of $130 million during fiscal 1983 through 1985 for fifteen major academic facilities. Considerable controversy surrounds these awards because they were made without competition and without the review procedures assumed by many to be an important element in such decisions. The controversy is stimulating debate about fundamental issues such as criteria for judging proposed facilities; mechanisms for balancing the various needs for scientific facilities; the proper roles of competition, technical review, and pertinent social, political, and economic factors; and the responsibilities of applicants, Congress, and the federal agencies. Restoration of funding authority to federal agencies and appropriation of funds would permit more effective distribution of capital support.

Several institutions are addressing the capital renewal problem through the use of industrial development bonds, land development, divestiture of assets, and lease-back arrangements with tax-depreciation benefits. Removal of the obstacles to responsible debt financing for higher education research facilities in several states could open another avenue of funding for capital renewal and replacement, but responsible use of this method demands realistic ways to amortize the costs. Indeed, there is some concern within the financial community about the rising level of university debt. More vigorous fund-raising efforts among alumni and friends of higher education will also have to occur.

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[33] Derek Bok, William G. Bowen, and Robert M. Rosenzweig, "Analysis of Treasury Department's Tax Proposals," December 13, 1984 (informal communication).

[34] Ibid., specific attachment entitled "A Comparison of the Costs and Potential Economic Benefits of the Treasury Proposal on Charitable Giving," December 11, 1984.

Some of the solutions may be useful on an ongoing basis, but some are necessarily nonrenewable. The long-term strategy for assurance of adequate investment in capital renewal and replacement will need to include recurring resources as part of the operating budgets. General economic recovery is perhaps the most critical element in the capacity of the various sectors to respond to the capital renewal and replacement needs in academic R&D.

In the search for solutions, ways to change the magnitude of the need for capital renewal and replacement should be examined. Careful attention should be given to the institution's criteria and mechanisms for assigning space among competing needs. Is existing space being used effectively? Can rearrangements provide substantial improvement without much cost? Many universities have already thoroughly explored this avenue. Most realignments within the existing space involve significant costs in remodeling and in dislocation and disruption of the activities affected.

Another avenue to be explored is the availability and accessibility of underused capacity in neighboring institutions and other organizations that have mutual interests. Cooperative arrangements with business and industry can make available needed facilities and equipment and at the same time stimulate intellectual exchange, especially in applied science and engineering. The logistical problems and costs of such solutions have to be recognized.

The new communication technologies offer major improvements in accessibility to shared facilities when data acquisition can be automated. The computing, astronomy, and high-energy physics communities are exploring these technologies and capitalizing on the opportunities they present. For many areas of science and engineering, however, telecommunication links and data transmission networks do not address the facilities problems faced.

Federal and state regulatory policy on environmental standards, on occupational health and safety, on access for the handicapped, and on laboratory animal welfare add to the need for capital renewal. Regulatory reforms might reduce the cost of filling these needs.

Specialization and stratification can reduce some needs. Perhaps the simplest example is the establishment of central instrumentation facilities, such as mass spectrophotometry centers, electron microscopy laboratories, and machine shops. The efficiency of such arrangements, however, depends on the nature and extent of the individual user's needs: some users will press the instruments to their limits, while some will use them more routinely.

Constraints on resources in the past fifteen years, and probably in the future as well, suggest that consolidation and stratification may have to provide part of the solution. The U.S. system of higher education is already partly stratified, as indicated by the concentration of most doctoral production and research activity in a few institutions. Institutions may have to cooperate and differentiate further if the United States is to continue to work at the frontiers in every field.

As a last resort we may need to reconsider the fundamental design features of our system. We may need to reexamine our adherence to some of its basic tenets, such as broad geographical dispersion, access to advanced education for a large portion of the population, and concentration of basic research in universities. The benefits of these design features have served this nation as well. Any major design would need genuinely favorable tradeoffs for both the short and the long term.

As we search for solutions we need to keep in mind the incentives that operate in a university setting, especially the need for individual flexibility and for organizational autonomy. We need to bear in mind the political realities of an annual budget cycle, a biannual election cycle, and dispersed responsibility for science within the federal government. Sustained support for long-term needs, such as capital renewal, has been difficult to achieve within this system. The present economic and demographic realities may provide the impetus for finding more effective ways to work with this system or for making some adjustment in it.

Policy issues related to capital needs

One fundamental question in the capital facilities debate is whether this country will try to sustain its leadership in science and technology, particularly in every field. Choices about capital renewal will affect the nation's capacity to meet these leadership objectives.

A second fundamental issue is the distribution of responsibility for supplying capital for basic research among the sectors that have contributed in the past—the universities, foundations and other philanthropic groups, state governments, and the federal government.

A third major issue is whether our current pluralistic system can provide adequate planning for the academic science on which the nation must depend. The system seems to provide inadequately for certain aspects of academic science, particularly renewal of facilities and equipment, training of new scholars, and incubation of new directions and new ventures. Over the long haul, a responsibly managed enterprise must make adequate provision for such needs. The key question is whether the structure of our particular system, which was designed to expand and improve capacity for graduate education and research, can be adjusted to provide for its sustenance and renewal. In whom shall we vest the principal responsibility for planning? How can we ensure the introduction of the necessary expertise and breadth of vision into the planning processes?

The values underlying the resolution of these policy issues need to be acknowledged, especially the commitment to excellence, the commitment to broad participation in education, the value placed on wide geographic distribution, and the commitment to government by the people, that is, widespread participation in decisionmaking processes.

Another category of issues involves the mechanisms for distribution of resources for capital renewal and the selection of criteria for setting priorities. One critical question is whether capital renewal resources should be treated separately from operating support at the appropriation level and the budget level. Construction authority has traditionally been separate from operating budget authority. Such a separation may be necessary to prevent shortsighted diversion of capital funds to operating uses to avoid programmatic reduction in periods of no growth or retrenchment. The present capital crisis has partly resulted from prolonged fiscal constraint. Institutions have repeatedly deferred maintenance and renovation in the hope that the fiscal constraints were only temporary. The existing construction authority for some of the National Institutes of Health (National Cancer Institute, National Heart, Lung, and Blood Institute, and National Eye Institute) has been used little or not at all, perhaps because construction authority and the operating budget authority are combined.[35] Research projects compete with capital projects for a pool of funds that is not commensurate with the scientific opportunities and the human resources available.

The peer review issue has emerged as critical for capital facilities for two reasons. One is the recent rash of intensive lobbying by individual institutions to obtain appropriations earmarked for facilities for their own institutions. The pork-barrel characteristics of this approach undermine the long-established commitment to allocate funds for science primarily in open competition among scientists and institutions and to include in the decision process the results of merit reviews made by professionals who are competent to judge. This commitment to fairness and to scientific merit is often cited as a major part of the productivity and vitality of American science.

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[35] Kurt Habel, "NIH Experience with Extramural Construction Authority," report prepared for Director of National Institutes of Health, Office of Associate Director for Program Planning and Evaluation (Washington, D.C.: National Institutes of Health, 1983).

The second reason for the importance of peer review in the capital facilities debate is the recurring controversy over indirect costs. When a federally sponsored R&D project uses university facilities, the government reimburses its share of the institution's indirect costs. Scientists are deeply concerned about the extent to which reimbursement of indirect costs reduces the amount of funds available for research projects under their direct control. Federal rules on the apportionment of indirect costs to research projects allow the recovery of part of the costs of buildings and equipment. The recovery rate through this mechanism, however, is far below what is needed for renewal and replacement of scientific equipment and facilities. The building use rate is based on a long life cycle (fifty years) and makes no provision for renewal and replacement of capital items purchased with federal funds. Considerable resistance within the institutions to the use of more accelerated depreciation rates results from the concern that indirect costs are already "too high." The concern arises because indirect costs are not subject to the same kind of peer review given to the direct costs of research projects.

Another set of issues involves how we will guide the evolution of graduate education itself. As the frontiers of science advance, the complexity, sophistication, and cost of the instrumentation and facilities increase. In some fields, it is already infeasible to provide the research facilities at the local level. In astronomy and high-energy physics, for example, most of the experimental work must now be done at national or even international facilities. Development in some other fields is also proceeding in this direction.

The implications of these trends for graduate education include earlier specialization by graduate students, less opportunity for interaction with persons in other fields or with students at the undergraduate level, and strain on the collegiality within the campus community. Faculty will share with nonfaculty professionals the responsibility for the development of the graduate student. The risks and benefits of that sharing need to be examined. The move to team supervision and team research is driven in part by internal scientific needs, but also in part by economics. The sharing of facilities, which brings together experimentalists from more than one discipline, may strengthen graduate education and contribute to the evolution of new disciplines. In a period of limited hiring of new faculty, such sharing may provide a useful mechanism for stimulating new ideas. The long-term effect of these developments on the quality of graduate education and on its benefits for undergraduate education must be considered.

Finally, stratification and specialization of institutions should be considered if sufficient resources cannot be garnered to allow the necessary capital renewal for all the institutions engaged in graduate education and research. There are obvious limits to what government can do in "targeting" assistance to research universities. Just as "picking winners" in industrial policy is impossible within the U.S. system, programs to support only selected institutions are problematic. Unless the benefits are broadly distributed, support for a program is difficult to mobilize. Although peer review has sustained the scientific enterprise in the United States, the siting of large-scale facilities involves more than judgments of scientific merit. The solutions for the universities' facilities problems will require a combination of strategies involving the institutions' own resources, their access to financial markets, and the support of industry and both the state and federal governments.

Data needed

A comprehensive inventory of needs for academic R&D capital renewal and replacement and a delineation of priorities should be agreed upon early as we look for solutions to the capital renewal dilemma. Such an inventory should be collaboratively designed by the academic institutions, industry, philanthropic organizations, and state and federal government. It should be designed with mutual understanding of the terminology and the criteria used in assessing the need. It should be differentiated by type of institution, by geographic location, and by field of science, and it should include information on the number of scientists and engineers the facilities would serve and on the cost and space utilization standards used to estimate need. The survey recently planned by the Interagency Steering Committee for Academic Research Facilities would provide some of those data.

In addition, we need to develop data on three aspects of the university research environment: trends in operating expenditures per research worker, trends in level of support staff per research worker, and trends in capital expenditures per research worker. The overall patterns of support could be plotted by using these trends for the United States by field of science and in total. Together with information about the rate of inflation for scientific expenditures, these data would show how well human and physical resources balance. Comparison of these patterns with those of other industrially developed countries will be important. Although some of the data needed to follow these trends are available, some are not. The present NSF data on R&D expenditures, for example, do not distinguish between facilities expenditures and equipment expenditures.

The space allocation standards widely used in academic institutions were developed many years ago. Since that time new disciplines have developed and old disciplines have changed. The current validity of the space standards needs to be examined, both to ensure wise decisions and to foster credibility for the fairness of the choices that will have to be made. We also need to take advantage of computer-assisted decision support systems to model changing facilities needs and to project realistic assessments of the capital investment requirements, at both the national and the institutional levels.

Trade-offs will occur between optimal arrangements designed for traditional behavior patterns and less expensive arrangements requiring changed work patterns. An analysis of the effect of changes in work patterns on scientific productivity could begin with a study of the use of regionally and nationally shared facilities. Such a study would focus on the numbers of research scientists and engineers dependent on the national and regional facilities as their principal source of data and on the trends in R&D expenditures at these facilities for university-based research scientists and engineers. Comparison of these data with data on total scientific manpower and R&D expenditures would permit monitoring of the shift of the principal research location away from the university campuses.

Better information is also needed about the incentives that operate in the academic setting and the factors that influence productive work patterns. When the means to realize career goals and the capacity to act in accordance with professional values are limited, the classical characteristics of anomie develop. An aging faculty and deteriorating facilities, together with the above limitations, may so seriously affect morale that a substantial number of the best and brightest minds will turn away from the satisfactions of science toward other pursuits.

Longer-term data needs include improved information on the effect of graduate education and research on economic growth and measures of the effect of technological changes on scientific productivity, graduate education quality, and faculty needs for capital equipment and facilities. Most existing information is qualitative and anecdotal. Research on correlations and causality is extremely difficult to do. Some investment in methodological research to develop indicators or surrogates for indicators would sharpen decisionmaking.

Conclusion

The pace and direction of science are affected by our capacity for ideas and insights, our understanding of the goals and needs to be served, and our human, physical, and financial resources. The continuing challenge is to find an acceptable balance among these factors. The capital renewal problem is a symptom of serious imbalance in our system.

The capital renewal problem presents a challenging dilemma. Although the academic R&D facilities renewal problem is large, its dimensions and its distribution among scientific fields and institutions remain undefined. Academic research is a significant element in maintaining the nation's technological and economic competitiveness, but the specific cause-and-effect links of the relationship have not been rigorously analyzed. The solutions to the facilities renewal problem will require multiple sources of support, but we have inadequate mechanisms for marshaling that collaborative support. Incentives and "market factors" guide investment in facilities, but these factors operate with a long lead time and are poorly understood.

The gap between the quality of industrial facilities and the quality of academic facilities (in which future industrial scientists are trained) contributes to the erosion of academic training. The consequences of this gap will grow.

The present uncertainties about the nature, the magnitude, and the consequences of the facilities renewal problem can be reduced. Efforts should certainly be expended toward reducing these uncertainties, but there are limits on our ability to understand deeply in a reasonable length of time or with reasonable cost. The strategy must be to converge toward solution, to reconcile the desire for detailed understanding with the limits on knowing, and to balance the risks of proceeding with inadequate information against the risks of delay.

What seems called for at the present crossroads is the following: interim strategies to limit the general decay of academic R&D

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facilities and to solve critical needs in high-priority areas; a comprehensive inventory of academic R&D facilities; indicators to monitor the status of facilities to target continuing investment in renewal and replacement; and collaborative efforts by the stakeholders (universities, governments, and industry) to develop a set of mechanisms to ensure that the infrastructure of American universities will support the academic enterprise that the nation needs.

Testimony on Research Facilities Revitalization Act

26 September 1985

S. Frederick Starr, President

Oberlin College

I. INTRODUCTION

I warmly commend the National Science Board's interest in undergraduate science. This level, after all, is not merely an early section of the "pipeline" from which future scientists emerge; it is the chief pumping station and filtration point along that pipeline. The undergraduate years are the last point at which large numbers of students not previously oriented toward science can be drawn into the enterprise, and, conversely, the point at which the largest attrition from the ranks of future scientists occurs.

It is well known that undergraduate interest in basic science has recently plummeted. Within a decade the percentage of American undergraduates intending to major in science fell by 33 percent, with the absolute number of such intended majors dropping by almost 40 percent*. Only slightly more than one in twenty freshmen on American campuses intends to major in science today, down from a high of one in ten in the late 1960s. Meanwhile, of course, our graduate schools are being filled by increasingly able students from abroad.

In the face of this erosion of America's human resources in science, any institutions that have maintained a contrary trend must become the object of urgent attention. In these remarks I would like to focus on a group of four dozen or so such schools that have successfully bucked the decline of the study of science nationally, namely, some four dozen private liberal arts colleges--"colleges of the arts and sciences" would be a better name--stretching from coast to coast. Drawing on research begun last year at Oberlin and continuing at this moment, I will sketch in the contours of these institutions' strong record in basic science, offer some explanations for their achievement, and suggest means by which the National Science Foundation might help assure continued strength in this quarter.

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*(the difference due to a drop in total enrollments).

II. THE "PIPELINE" FOR SCIENTISTS: CHANGES IN FLOW

The rapid and sustained national decline in interest in basic science has affected nearly all types of colleges and universities. Since 1975, public universities collectively have seen freshman intention to major in science fall a precipitous 37 percent, from 13 percent of their students to only 8 percent in 1984. And private universities have fared even worse over this period, falling from 22 percent interest in science to 12 percent, a -45 percent change. Even the most highly selective of the private universities have experienced a 34 percent reduction in the proportion of students intending science majors (from 26 percent in 1975 to only 17 percent in 1984). And the colleges as a group, even the privates, also witnessed nearly 40 percent reductions in prospective science majors since the mid-1970s.

These trends are not limited merely to freshman intention. They translate into almost equally serious, and just as universal, declines in both proportion and absolute numbers of undergraduates being awarded baccalaureate degrees in the basic sciences. The national volume of undergraduate degrees awarded in all science fields fell fully 17 percent between 1975 and 1981, from 87,442 to 72,223. In contrast, total baccalaureate production actually rose slightly (from 931,663 to 935,410) over this period. Thus, the proportion of all baccalaureates being conferred as degrees in the sciences fell from 9.4 percent to 7.7 percent, a -23 percent change. Again, even the best research universities were seriously affected. The 20 public and private universities with the best-rated graduate programs by the National Academy of Sciences conferred 14 percent fewer undergraduate degrees in basic science in 1980 than they had only four years earlier (8,114 down to 6,974). As a proportion, this decline translates as a drop of over 11 percent, from 16 percent to 14 percent of all baccalaureate degrees awarded by America's premier research universities.

The major liberal arts colleges have shown themselves to be virtually immune to these strong negative trends. Since 1975, their proportional freshman intention to major in science has remained steady at from 28 to 31 percent. This is more than four times the national average, better than twice the 12 percent proportion of the most selective public universities, and two-thirds greater than the level of interest in science at the best private research universities. Moreover, unlike these schools, and the nation at large, the level in science interest at these four dozen colleges since the mid-1970s has been almost flat, that is, nearly completely resistant to the unfavorable trends at even the best universities.

Considering actual undergraduate degree production, the bottom line after attrition, the performance of these leading colleges is even stronger. Again, the proportion of all their baccalaureates awarded in the sciences has been an unflagging 24 percent since 1975, and the absolute number of science degrees conferred has actually risen fully 16 percent, from 4,450 to 5,150, by 1983. Thus the colleges are uniquely able to sustain their students' interest in science.

The colleges' positive trends on all fronts in the face of downward ones nationally indicate that these select undergraduate institutions are rapidly becoming more important to America's science pipeline. In 1975, the leading colleges provided 42 per thousand of the nation's B.A.s in science. In 1980, their share was 54 per 1,000, a 27 percent growth. In contrast, the 20 top-rated public and private research universities' baccalaureate share rose barely one percent, from 92.6 per thousand to 93.5 per 1,000 over this period.

The fact that these data have not been generally known until recently must be traced to the liberal arts colleges themselves, few of which appreciated their distinctive contribution to basic science in the U.S.A. In the absence of data, it was easy to assume that the strongest undergraduate science was to be found at the same "research universities" where graduate study flourishes. This is not necessarily so.

Are liberal arts colleges enriching American science with persons of exceptional talent? The fact that the four dozen liberal arts colleges under discussion surpass all but a handful of universities in the percentage of their graduates who go on to get Ph.D.s in science attests to the strength of their student body in these fields. It is no wonder that alumni of such schools have included such distinguished scientists as Nobel Prize laureates Arthur Compton, Robert Millikan, Roger Sperry, and Charles Townes.

Are liberal arts colleges also broadening the social base of American science? Nothing speaks more eloquently to this issue than the unparalleled recruitment of women into science at the liberal arts schools. Fully 52 percent of basic science majors at such schools are women, far higher than the corresponding figure at public or private research universities, the Ivy League, etc. Data on blacks and other minorities is not yet at hand, but they are probably analogous, given these schools' vigorous recruiting.

III. WHY LIBERAL ARTS COLLEGES EXCEL AT SCIENCE

The obvious explanation for the success of liberal arts colleges in science is that they are undergraduate institutions, not universities. There are no graduate students to claim professors' time nor do they substitute for seasoned professors as teachers. Faculty members in colleges are expected to devote more of their time to teaching, all of it, of course, being directed toward undergraduates. As a result, the actual classroom ratio of permanent faculty and undergraduate students is far higher at these schools than at even the finest universities.

This affects all levels of teaching. One-third to one-half of all science courses at liberal arts colleges are at the introductory levels, thus stimulating the recruitment of majors. Of these introductory courses, half are taught by tenured members of the faculty, people with at least six years of classroom experience and a proven professional commitment to undergraduate education. Of course, top undergraduate scientists receive excellent training at the leading universities and colleges alike. Only at the liberal arts colleges, however, are they so likely to be drawn into advanced research in any numbers, and only at these schools are they so likely to be placed in the relationship of apprentice to their professors. The very practical reason for this is that faculty researchers at these colleges have no graduate students to employ in their laboratories. Lacking them, professors have no choice but to train undergraduates to fill such assignments. To assure continuity, professors generally identify promising freshmen and sophomores, who thus become collaborators over a period of three or four years. It is not surprising, therefore, that nearly one-third of all journal articles published by liberal arts college faculty during the past five years are coauthored with undergraduates, a rate far higher than for research universities on which data is available.

But do professors at liberal arts colleges really conduct research? Most definitely. Some 350 books, 6,961 journal articles, and 4,478 conference papers were authored by scientists from the four dozen leading colleges over the past five years. 60 to 65 percent of all college faculty publish regularly, most of these being in the younger ranks. To be sure, the more modest scale of laboratories and instrumentation at such schools distorts somewhat the subfields in which such research is concentrated. Moreover, the fact that college-based research is viewed in part in its relationship to undergraduate teaching also influences the research agenda to some degree. But the overall emphasis upon research at such institutions is firmly rooted. They can with justice be termed America's "research colleges." Recently, the Committee on Professional Training of the American Chemical Society declared

> In the Committee's judgment, the best indicator of the probable excellence of a baccalaureate degree program is the emphasis on undergraduate research.../undergraduate research/ is the best education we can offer the younger generation in preparation for service to society as chemists.

By this measure, liberal arts colleges are a central component of American science.

IV. THE FUNDING OF SCIENCE AT LIBERAL ARTS COLLEGES

Roland W. Schmitt, Chairman of the National Science Board, has observed that "no systematic federal leadership or support exists for science...at the undergraduate level." Since World War II the United States has built up several hundred "multiversities" as centers for advanced research and graduate study in science. We are all indebted to this investment, which has established America's global leadership in many fields. Meanwhile, however, the top liberal arts colleges were neglected. In 1982 the 100 principal research universities garnered 86 percent of all NSF grants to higher education, and 91 percent of all federal grants for facilities and instrumentation for instruction. Of all federal support for research and development to academia, 98 percent goes to universities.

In spite of their small base, liberal arts colleges are seeing a rapid decline in federal support. All federal support to the four dozen colleges between 1978 and 1982 dropped by 28 percent in real value, while their NSF support in real dollars plummeted fully 65 percent during those years. Fewer than half of the four dozen institutions received any help at all for facilities and teaching instrumentation in 1978. In 1982 none of them did.

Let me restate this point: THOSE INSTITUTIONS WITH SOME OF THE STRONGEST RECORDS IN EDUCATING UNDERGRADUATE SCIENTISTS HAVE DRAMATICALLY IMPROVED THEIR SHARE OF THE PROSPECTIVE SCIENCE MARKET IN RECENT YEARS, IN THE FACE OF GRAVE EROSION NATIONALLY; THEY HAVE ALSO IMPROVED THEIR ABSOLUTE NUMBER AND SHARE OF U.S. TOTAL B.A. PRODUCTION IN BASIC SCIENCES. NEITHER OF THESE RECORDS CAN BE CLAIMED BY PUBLIC OR PRIVATE RESEARCH UNIVERSITIES. THESE SAME INSTITUTIONS, HOWEVER, HAVE RECEIVED ONLY A TRIVIAL AMOUNT OF FEDERAL HELP IN SUCH CRUCIAL AREAS AS RESEARCH INSTRUMENTATION GRANTS SINCE THE ESTABLISHMENT OF THE NATIONAL SCIENCE FOUNDATION, AND EVEN THAT AMOUNT HAS RECENTLY FALLEN PRECIPITOUSLY. IN SHORT, TOP LIBERAL ARTS COLLEGES ARE ACCOMPLISHING FAR MORE WITH FAR LESS.

Is this not an ideal situation? After all, such schools have avoided any unwholesome dependence upon federal support. They have sustained a remarkable record with their own resources, remaining free not only from federal entanglements but also from corporate sponsors, which have also concentrated their giving overwhelmingly on multiversities, both public and private.

Unfortunately, the picture has a darker side. To paraphrase Voltaire, the colleges have been living off the capital of another era. None can compete successfully with even minor universities in such areas as start-up costs and summer research stipends for young scientists, let alone salaries and instrumentation. Of course, the college-based researcher expects to have less time for his own work, but is it reasonable that the percentage of his research time that is externally funded is only half the amount for colleagues at all universities? Nor is the college scientist's basic salary secure. The endowment dollars per student at major private universities far surpasses the figure for leading colleges, and the gap is widening. This means that basic costs for the scientific enterprise on college campuses are increasingly dependent upon tuition payments, and at a time when all institutions of higher education are facing the so-called "baby bust." Finally, it must be noted that many laboratories at liberal arts colleges were built up during periods of affluence. Without external assistance, there is absolutely no way that comparable laboratories for instruction and research can be maintained on these campuses in the future.

V. WHAT IS THE APPROPRIATE ROLE FOR THE NATIONAL SCIENCE FOUNDATION?

Liberal arts colleges have no interest in weakening support for science at leading universities. The two categories of institutions are linked in a common enterprise, and they benefit one another in numerous ways. What is called for is not some wholesale shift in funding (which would not occur under any circumstances) but an adjustment of emphasis that would benefit undergraduate science everywhere.

What would this shift in emphasis involve? The 48 liberal arts colleges of which I have been speaking are devoting the present year to further research on this point. They are evaluating their future investment needs and comparing them with possible sources of support. Fuller recommendations will be in hand by June, 1986. Meanwhile, the following steps appear desirable:

1. Recognize the leading "research colleges" as being as distinctive a subset within American science as the leading "research universities," and enhance support of undergraduate science on these campuses in the same way that graduate education has been supported at leading universities. The group of colleges should be defined solely on the basis of student and faculty performance and institutional commitment and not by some undesirable form of entitlement. Obviously, institutions listed with this group would change from time to time, as happens among universities.

2. Assure that qualified scientists from such institutions are included on all the relevant boards, councils, and panels of the National Science Foundation, beginning with the National Science Board and, conversely, that senior university-based scientists serve on all councils and panels dealing with undergraduate science.

3. Strengthen existing undergraduate science and instrumentation programs within NSF and establish a special fund within them for the most productive liberal arts and science colleges. This fund could provide one-time grants to defray set-

up costs, summer stipends for junior faculty, grants for research leaves, etc.

4. Restore the program of faculty research leaves that previously brought great benefits to liberal arts college scientists but was subsequently dropped.

5. Link scientists on liberal arts undergraduate campuses with major NSF sponsored projects at universities and national research centers through paid leaves of absence. This could be accomplished by providing bonuses for including professors at undergraduate institutions in large research grants.

5. Most important, the NSF should explore the possibility of substantial one-time grants in endowment to underwrite distinguished professorships in science at leading undergraduate campuses. The National Endowment for the Humanities has a similar program that could serve as a model. One-time major instrumentation grants should also be considered, on a matching basis.

This list is meant to be suggestive, not exhaustive. It does indicate, however, that no serious progress will occur until the NSF acknowledges the centrality of colleges of the liberal arts and sciences to the scientific enterprise in the United States. It has acknowledged the special role of leading research universities, concentrating more than four-fifths of its general academic support and nine-tenths of its facilities and instrumentation support in a mere 100 institutions. In other words, the principle of focusing NSF support on institutions of proven quality has long been established in the case of universities. This should now be done for undergraduate colleges as well.

AJCU
ASSOCIATION OF
JESUIT COLLEGES & UNIVERSITIES
1424 SIXTEENTH STREET, N.W. • SUITE 300 • WASHINGTON, D.C. 20036 • 202/667-3889

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Spring Hill College, Ala.
University of Detroit, Mich.
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University of Santa Clara, Calif.
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Wheeling College, W. Va.
Xavier University, Ohio

October 22, 1985

The Honorable Don Fuqua
Chairman, Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Fuqua:

On behalf of the Association of Jesuit Colleges and Universities, I wish to submit the following statement for the hearing record on H.R. 2823.

In general, the Association supports the testimony of John Wright, President of the University of Alabama in Huntsville, submitted on behalf of the American Association of State Colleges and Universities on October 22, 1985. His concluding remarks on ideals are particularly appropriate and in conformity with the thrust of H.R. 2823, the University Research Facilities Restoration Act:

* An acknowledgement that facilities are a real and mandatory factor in determining the costs of a comprehensive research infrastructure
* Recognition that support for education and research facilities is an investment in our nation's economy
* An appreciation of the benefits of a diverse research community and the corresponding needs of its members
* An understanding of the dependence of each institution's education and research efforts upon its physical infrastructure.

We would, however, go beyond this statement of ideals and suggest that the present bill is too heavily weighted in favor of a few universities. Recognizing that there is renewed interest in not only scientific research, but science and engineering education by both the National Science Foundation and the National Science Board, we would recommend that no restrictions or limitations be placed on eligibility for facilities funds at the National Science Foundation. NSF, as you know, has broad support for all research and education in the sciences as its mission, unlike agencies such as the Department of Defense and NASA. Consequently, we are convinced that the present draft language that allocates only $15 million (out of a total of $100 million) to institutions receiving less than $10 million in federal science support is not appropriate to the NSF mission. We recommend that both distributive percentage amounts and floor/cap levels be eliminated for facilities funding at the National Science Foundation.

Respectfully,

Joseph Kane

Joseph Kane
Vice President

cc.: The Honorable Manuel Lujan

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November 7, 1985

Mr. Ellis K. Fields
President
American Chemical Society
1155 16th Street, NW
Washington, DC 20036

Dear Mr. Fields:

Thank you for your encouraging comments on H.R. 2823, the University Research Facilities Revitalization Act of 1985.

If you have no objections, I plan to have your letter of November 5 included in the Subcommittee's hearing record on H.R. 2823.

On behalf of the Subcommittee, I wish to express my appreciation for the views of the American Chemical Society on this important legislation.

Sincerely,

Doug Walgren

DOUG WALGREN, Chairman
Subcommittee on Science,
Research and Technology

DW/Hdh

American Chemical Society

OFFICE OF THE
PRESIDENT

Ellis K. Fields
President-Elect, 1984
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Immediate Past President, 1986

1155 SIXTEENTH STREET, N.W.
WASHINGTON, D.C. 20036
Phone (202) 872-4600

November 5, 1985

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research and Technology
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Walgren:

The American Chemical Society supports the concept of H.R.2823--the "University Research Facilities Revitalization Act of 1985"--and commends your Subcommittee for conducting hearings on this bill. There is a large and growing recognition of the need for funds to build and to modernize scientific research laboratories. The exact magnitude of the problem is not yet known; however, consideration of H.R.2823 is a necessary first step in addressing this issue.

The Society believes that, at the same time this legislation is being considered, a federal study should be conducted to assess the Nation's current and projected need for new and renovated buildings devoted to scientific research. Since the National Science Foundation currently administers the data collection for instrumentation needs at universities, the ACS supports provisions in the authorizing legislation for NSF as well as in this bill that would encourage the Foundation to conduct such a study. Once a nationwide assessment has been completed, the results should be used to guide the construction of any future legislation that will address agency-specific mechanisms to meet effectively the needs for research facilities at colleges and universities.

While the American Chemical Society expresses support for H.R.2823, the Society has reservations that the federal funds used for facilities programs will erode the federal agency R&D budgets. Any subsequent reduction of the funds available for research would be of grave concern to the ACS.

In conclusion, the Society wishes to provide whatever assistance it can to your Subcommittee as you consider this important legislation.

Sincerely yours,

Ellis K. Fields

Ellis K. Fields

American
Psychiatric
Association

1400 K Street, N.W.
Washington, D.C. 20005
Telephone: (202) 682-6000

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Deputy Director,
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November 8, 1985

Honcrable Doug Walgren
Subcommittee on Science, Research
  and Technology
Committee on Science and Technology
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

The American Psychiatric Association, a medical specialty society representing over 31,000 physicians nationwide, appreciates this opportunity to present its views on H.R. 2823, "University Research Facilities' Revitalization Act of 1985." The Association's membership has long been committed to participating in the nation's biomedical and behavioral research effort supported by both the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA) and the National Institutes of Health.

While the hearing witnesses focused on the need for Federal investment in uni.ersity research laboratory construction and renovation under the auspicies of the NIH, we want you to know that these issues are equally -- and perhaps more -- profcund for research supported by the ADAMHA, particularly new and sophicticated brain and behavior research.

For example, the APA has shared with you a brochure we developed about ADAMHA's NIMH excellent research activity (copy enclosed). Hopefully it has brought to your attention several of the major developments in refining techiques for quantifying and imaging of live human brains.

These include Computerized Tomography (CAT scans) and Nuclear Magnetic Resonance (NMR) imaging which have made it possible for clinicians to assess regional brain anatomy; isotopic techniques such as regional cerebral blood flow by Xenon inhalation and Positron Emission Tomography (PET scans) which provide measures of regional brain flow and metabolism; and computerized electroencephalograms which yield regional measures of neuronal electric activity. These technological advances now permit the development of a whole new method for the study of mental disorders, but the necessary equipment is expensive and clearly beyond the scope of the regular research project grant mechanism. These new and exciting technologies have historically been available only for the ADAMHA intramural research programs, where they have proven to be invaluable to the national research endeavor, but available to only a small percentage of the outstanding ADAMHA researchers across the nation.

Much of the equipment in the extramural programs, by contrast, was purchased years ago and is currently not state-of-the-art; consequently there is a massive and largely unmet need for the modernization and rehabilitation of existing facilities and for the constuction of new facilities. We feel, as do you, that the federal government, through the National Science Foundation, should immediately begin to monitor the facility requirements of the nation's research universities.

As you know, last year a major survey of 249 universities and medical schools resulted in the finding that while there is a high level of interest in facilities renovation and construction, grantees admitted that they more often than not lacked necessary facilities and equipment — 80% of those surveyed felt that their facilities were not state-of-the-art and 50% reported that their systems were in states of disrepair. Estimated replacement costs for this equipment totalled $863 million in 1982 dollars.

The prestigious Institute of Medicine of the National Academy of Sciences provided further amplification of the need for investment in research equipment and facilities for investigators within the ADAMHA domain in its landmark report entitled, "Research on Mental Illness and Addictive Disorders: Progress and Prospects." The IOM states:

> Biological and psychosocial research groups throughout the country have pressing needs in these areas that go beyond the desire to acquire and apply the latest technological innovations. Many neuroscientists now must conduct their research with outmoded equipment that lacks the sensitivity and accuracy demanded of contemporary work in fields such as biochemistry, analytic chemistry, and neurophysiology. Some psychosocial researchers also have urgent infrastructure needs, for example, large computers and controlled environment settings for individual and group studies. Traditionally, with the overall extreme shortage of funds, only a tiny fraction of the ADAMHA budget has gone to support equipment and facilities, yet, for many outstanding programs, replacement and upgrading of equipment has become imperative. Such investments must be considered

> carefully, but, in many instances, continued progress will be impossible without active assistance from ADAMHA.

We attach a copy of this comprehensive report for your review.

While we thus support the general thrust of H.R. 2823, we do wish to associate ourselves with the views of the Association of American Medical Colleges (AAMC) on the legislation's proposed funding mechanism, e.g. the 10 percent set-aside of the DHHS R&D budget for a facilities program. This rigid mechanism may preclude flexibility in facilities funding and may render the Congress unable to devote resources to non-facilities R&D. We support an approach to the problem through a broad, permanent construction authority for DHHS which would give the Appropriations Committees the flexibility to meet the particular needs of each agency and rely on latest estimates of need.

The Association appreciates the opportunity to comment on this important legislation and looks forward to working with your Subcommittee on H.R. 2823.

Sincerely,

Melvin Sabshin

Melvin Sabshin, M.D.
Medical Director

Enclosures

MS:JBC:FF:jdc

cc: Members, Committee on Science and Technology

THE ASSOCIATED NATURAL SCIENCE INSTITUTIONS
499 SOUTH CAPITOL STREET, S.W. - 407
WASHINGTON, D.C. 20003
(202) 554-7983

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA
THE MUSEUM OF NATURAL HISTORY OF LOS ANGELES COUNTY
THE FIELD MUSEUM OF NATURAL HISTORY
THE AMERICAN MUSEUM OF NATURAL HISTORY
THE CALIFORNIA ACADEMY OF SCIENCES

November 14, 1985

Mr. Ezra Heitowit
Staff Director
House Science Subcommittee on
Science Research and
Technology
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Ezra:

The enclosed amendment to the Higher Education Act, which was agreed to by the Education and Labor Committee, is intended to allow consortia of museums and universities qualify for fellowship awards. It seems to me that it may be a model for a change in Mr. Fuqua's infrastructure bill.

In the case of H.R. 2823 we would not be concerned with consortia nor would benefits accrue to institutions engaging in cultural research. Paragraphs (D) and (E) also would not be needed. Therefore the following might suffice:

"Qualified institutions also include any organization which --

> "(A) is described in section 501(c)(3) of the Internal Revenue Code of 1954, and is exempt from tax under section 501(a) of such Code;
>
> "(B) is organized and operated substantially to conduct scientific research and graduate training programs;
>
> "(C) is not a private foundation."

Qualified institutions that would be included in the definition would be the independent biomedical institutions but eliminated would be those that are not also charitable entities. You may want to include not-for-profits that are not charitable in which case eliminate the 501(c)(3) requirement.

I hope this is helpful.

Sincerely,
Newton
Newton O. Cattell
Director

NOC
Enclosure

BIAGGI206

AMENDMENT TO H.R. 3700
OFFERED BY MR. BIAGGI

Page 559, line 12, insert ``(1)'' after the subsection heading, and after line 17, insert the following new paragraph:

``(2) The Secretary may also make grants to such departments and programs and to other units of institutions of higher education granting graduate degrees which submit joint proposals involving non-degree granting institutions which have formal arrangements for the support of doctoral dissertation research with degree-granting institutions. Non-degree granting institutions eligible for awards as part of such joint proposals include any organization which--

``(A) is described in section 501(c)(3) of the Internal Revenue Code of 1954, and is exempt from tax under section 501(a) of such Code;

``(B) is organized and operated substantially to conduct scientific and cultural research and graduate training programs;

``(C) is not a private foundation;

``(D) has academic personnel for instruction and counseling who meet the standards of the institution of higher education in which the students are enrolled; and

``(E) has necessary research resources not otherwise readily available in such institutions to such students.

esa

ESA, INC.

45 WIGGINS AVENUE
BEDFORD, MA 01730
617-275-0100 • TELEX 923344

November 18, 1985

RECEIVED
NOV [illegible]
COMMITTEE ON SCIENCE
AND TECHNOLOGY

Honorable Don Fuqua
Chairman
Committee on Science
and Technology
U.S. House of Representatives
2321 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Chairman:

ESA, Inc. would like to express support for the bill you have introduced, H.R. 2823, the Facilities Revitalization Act of 1985.

As a manufacturer of advanced electro chemical measurement devices, as well as other technologically advanced diagnostic chemical environment tools, I am aware of the great advances that could be made if each researcher around the nation had the most up-to-date facilities and state-of-the-art diagnostic and testing equipment. Believe me, available technology is growing in leaps and bounds and it is very difficult for researchers to maintain the best equipment. Further, many are so busy conducting their research that they are not aware of new technology.

A reservation we have with H.R. 2823 is that the mechanism for funding of this program would significantly reduce research budgets at other federal agencies. We are supportive of current biomedical and other critical research that is being conducted throughtout our federal agencies. A 10% reduction in their research budgets may have an adverse effect on their efforts to conduct trials of concern to their jurisdiction.

Again, Mr. Chairman, we commend your efforts to re-build the nation's research facility infrastructure.

Please make this statement part of your hearing record for October 30, 1985, Subcommittee on Science, Research and Technology.

Sincerely,

Alvin Block

Alvin Block
President

cc: Ezra Heitowit, House Subcommittee on Science, Research and Technology

AMERICAN COUNCIL ON EDUCATION
Division of Governmental Relations

November 19, 1985

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research
and Technology
Science and Technology Committee
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I write with regard to your recent hearings on the University Research Facilities Revitalization Act. The American Council on Education would like to be associated with the views expressed by Dr. John Wright, President of the University of Alabama at Huntsville, who testified on behalf of the American Association of State Colleges and Universities (AASCU).

Our endorsement of the AASCU statement complements our cosponsorship with the Association of American Universities and the National Association of State Universities and Land-Grant Colleges of the testimony presented by President Marshall Criser of the University of Florida. Taken together, the two statements convey a sense of the universal importance which all segments of higher education attach to this legislation.

The critical need for improving and upgrading the nation's science education and research infrastructure has been amply documented and fully addressed in the testimony you have heard. A more difficult task is the development of an appropriate formula for channeling support to the various sectors of higher education in accordance with their respective needs.

Any determination which attempts to differentiate between the needs of the research institutions and those whose mission primarily is education and training must necessarily be arbitrary. The provision in HR 2823 setting aside 15 percent of the total funding to be made available for institutions not among the top 100 research universities may be the least arbitrary designation in that it reflects current patterns of support. However, as new resources can be found for facilities rennovation, it is our hope that the percentage of funding for institutions committed to the education of science and engineering baccalaureates can be increased.

One Dupont Circle, Washington, D.C. 20036-1193 (202) 939-9355

It is important, also, to call the Committee's attention to an unintended but significant benefit of HR 2823. The higher education associations have repeatedly urged Congress to uphold the competitive review process which allocates resources equitably based on valid judgments regarding the merit of a proposed project, and we have called on Congress to reject the practice of earmarking legislation for specific projects at individual colleges and universities. Such efforts by individual institutions, while deplorable, will surely continue in the absence of a credible competitive alternative. In its comprehensive approach to improving the education and research infrastructure, HR 2823 represents a most promising alternative.

I would like to commend the Committee for its extensive examination of the facilities problems afflicting every segment of the higher education community, and respectfully ask that this letter be included in the hearing record.

Sincerely,

Charles B Saunders Jr

Charles B. Saunders, Jr.
Vice President for
Governmental Relations

PUBLIC AND SCIENTIFIC AFFAIRS BOARD
AMERICAN SOCIETY FOR MICROBIOLOGY

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Telephone: (202) 822-9229

January 21, 1986

The Honorable Don Fuqua
Chairman, House Committee on Science
and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Representative Fuqua:

The American Society for Microbiology (ASM) wishes to submit its views on H.R. 2823, The University Research Facilities Revitalization Act of 1985. With an active membership of over 34,000, the ASM is the largest single biological life science organization in the world. ASM members contribute to the applied fields of infectious diseases, clinical microbiology, epidemiology, industrial fermentation processes, ecological microbiology, agricultural microbiology and food technology, as well as to the fundamental areas of molecular biology, immunology, genetics, virology, oncology, microbial physiology, environmental microbiology, mycology and host parasite interactions. Because many ASM members are involved in research, the Society has a major interest in legislation to establish greater federal investment in the physical infrastructure for research.

The ASM supports the objectives articulated in H.R. 2823, and views the bill as a constructive step toward renewing the aging research facilities at many universities and colleges and establishing an ongoing process for maintaining an adequate level of infrastructure integrity in the future. We believe the need for updating facilities is real and urgent. The intensity of the perceived need is reflected by the recent adoption of the practice of pressing appeals directly to Congress, urging direct appropriations for the renewal of specific university facilities in some states. More equitable and effective would be a federal university research facility grant program of the type that is proposed in H.R. 2823, a program that would utilize a system of peer review, would evaluate the scientific merits of competing proposals and would provide regular and fair competitive paths for the reversal of infrastructure obsolescence and age. The ASM is in general agreement with the objective, but we suggest that some changes be made in particular provisions of the bill.

First, although we support a program of federal funding for renovation and construction of modern research facilities at universities, we do not agree that facilities renewal funds should be derived as set-aside percentages of the R & D budgets of the six largest federal agencies. We favor a mechanism for funding infrastructure renewal programs from new appropriations made for that purpose. We do not favor redirection of funds that were intended for other purposes. To this end we would recommend establishing a separate construction authority to receive and administer funds for infrastructure renewal. We support the approach of providing matching funds in concert with states, universities or industries.

Second, we recommend introduction of some flexibility in determining the amounts of money to be devoted to facilities update. A single percentage number, 10% of the R & D budget is proposed in the bill. We believe it would be wise to leave room for year-by-year and case-by-case analysis. A percentage value (perhaps 5% is more realistic in today's budget atmosphere) could be established as a guideline for determining the approximate desirable funding level, but the actual amount to be appropriated and expended should take into account the differences in the character of the needs in various scientific disciplines and the degree of urgency of the particular need. Flexibility should also be retained in order to be able to deal constructively with cases of unusual hardship.

Third, we endorse the proposal that the National Science Foundation undertake a study of the status of existing research facilities and their need for renewal, and we recommend that the analysis be continuously updated in future years. We recommend that scientists who are actively involved in research should play a prominent role in formulating the analysis of need for renewal of facilities.

Fourth, we suggest that a clear distinction be made between equipment/instrumentation on the one hand and buildings/laboratories on the other hand. There are existing avenues for acquisition and replacement of some types of equipment, and these avenues should continue to be utilized. The emphasis of the Revitalization Act should be to support replacements, acquisitions, construction and reconstruction that can be effected in no other way. As such, the goals and objectives of the bill are of utmost importance to the future health and vigor of science in the United States.

The ASM is pleased to acknowledge the constructive and positive role that a Facilities Revitalization Act would play in the future of science in this country, and stands ready to assist in any way it can as the details of the provisions of the bill are perfected in the upcoming months.

Sincerely,
Moselio Schaechter
Moselio Schaechter, Ph.D.
President, American Society for Microbiology
H.O. Halvorson
Harlyn O. Halvorson, Ph.D.
Chairman, Public and Scientific Affairs Board
Monica Riley
Monica Riley, Ph.D.
Chairman, Committee on Genetic and Molecular Microbiology

cc: The Honorable Doug Walgren

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-6371

September 12, 1985

Hon. John R. Block
Secretary
Department of Agriculture
Washington, D.C. 20250

Dear Mr. Secretary:

H.R. 2823, the "University Research Facilities Revitalization Act of 1985", has been referred to the House Committees on Science and Technology, Energy and Commerce, Armed Services, and Agriculture. The purpose of this legislation is "To assist in revitalizing the Nation's academic research programs through capital investments in laboratories and other research facilities at universities and colleges. To carry out this purpose, each of the major Federal research and development agencies shall establish and carry out a new university research laboratory modernization program, under which an amount equal to a specified portion of the funds available to the agency involved for research and development awards to institutions of higher education will be reserved for the replacement or modernization of such institutions' obsolete laboratories and other research facilities."

I am enclosing a copy of H.R. 2823 for your review and would appreciate your written comments, no later than October 15, 1985. The views and recommendations of your Agency will be helpful to the Subcommittee on Science, Research and Technology in its present consideration of this legislation. A series of hearings is presently scheduled for October by the Subcommittee.

Should you have any questions concerning H.R. 2823, please contact Dr. Ezra Heitowit, Staff Director of the Subcommittee at 225-8844.

Thank you for your cooperation. I look forward to hearing from you.

Sincerely,

Doug Walgren

DOUG WALGREN, Chairman
Subcommittee on Science,
Research and Technology

DW/pt
Enclosure

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

January 29 1986

Honorable Doug Walgren
Chairman, Subcommittee
on Science, Research and Technology
Committee on Science and Technology
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

This is in response to your request for comments on H.R. 2823, the "University Research Facilities Revitalization Act of 1985".

The Department does not recommend the enactment of this bill.

H.R. 2823 would require university and college research laboratory modernization programs in six Federal agencies, including the Department of Agriculture. The bill would authorize $470 million in FY 1987 for the program of which $25 million would be for the Department of Agriculture. For the second through the tenth years of the program, each of the six agencies would be required to reserve for such a program: (1) at least 10 percent of the amount appropriated to such agency for obligation by it for R&D awards to universities and colleges or (2) the amount by which its university R&D budget for the current year, plus the amount reserved for facilities in the preceding year, exceeds its university R&D budget for the preceding year, whichever is lower. The effect of the formula, as we understand it, is to provide that in those years where appropriations for R&D funding are decreased, the facilities set aside also would be reduced and could, in fact, be zero depending on the decrease of funding for R&D activities.

In light of a large Federal budget deficit, it seems inappropriate to establish a new Federal program. In addition, H.R. 2823 imposes a formula requiring a certain portion of R&D appropriations to be set aside for the replacement and modernization of facilities. This could have the affect of modernizing facilities at the expense of ongoing research. Another troublesome part of the bill is the requirement that at least 15 percent of the amount set aside be made available only to universities and colleges that received less than $2,000,000 in total Federal obligations for R&D in each of the two preceding fiscal years. This requirement likely would force spending a significant part of the funding at institutions with quite limited research capability.

As a result of the Department of Agriculture's interest in modernization of research facilities, it proposed revisions of the Research Facilities Act of 1963 (7 U.S.C. 390 et seq.) which were enacted as a part of the 1985 Farm Bill (P.L. 99-198). The amended Act authorizes a program with a similar purpose, but with greater flexibility than H.R. 2823 to address the special needs of agriculture. We believe that the recently enacted revision of the 1963 Act is more appropriate, and we do not favor the approach of H.R. 2823.

We are advised by the Office of Management and Budget that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

John R Block

John R. Block
Secretary

DON FUQUA, Florida, Chairman

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Executive Director
ROBERT C. KETCHAM
General Counsel
JOYCE GROSS FREIWALD
Republican Staff Director

September 12, 1985

Hon. Margaret M. Heckler
Secretary
Department of Health and Human
Services
Washington, D.C. 20201

Dear Madam Secretary:

H.R. 2823, the "University Research Facilities Revitalization Act of 1985", has been referred to the House Committees on Science and Technology, Energy and Commerce, Armed Services, and Agriculture. The purpose of this legislation is "To assist in revitalizing the Nation's academic research programs through capital investments in laboratories and other research facilities at universities and colleges. To carry out this purpose, each of the major Federal research and development agencies shall establish and carry out a new university research laboratory modernization program, under which an amount equal to a specified portion of the funds available to the agency involved for research and development awards to institutions of higher education will be reserved for the replacement or modernization of such institutions' obsolete laboratories and other research facilities."

I am enclosing a copy of H.R. 2823 for your review and would appreciate your written comments, no later than October 15, 1985. The views and recommendations of your Agency will be helpful to the Subcommittee on Science, Research and Technology in its present consideration of this legislation. A series of hearings is presently scheduled for October by the Subcommittee.

Should you have any questions concerning H.R. 2823, please contact Dr. Ezra Heitowit, Staff Director of the Subcommittee at 225-8844.

Thank you for your cooperation. I look forward to hearing from you.

Sincerely,

Doug Walgren

DOUG WALGREN, Chairman
Subcommittee on Science,
Research and Technology

DW/pt
Enclosure

THE SECRETARY OF HEALTH AND HUMAN SERVICES
WASHINGTON, D.C. 20201

OCT 24 1985

The Honorable Doug Walgren
Chairman, Subcommittee on
Science, Research and
Technology
Committee on Science and
Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

This is in response to your request for a report on H.R. 2823, a bill "To assist in revitalizing the Nation's academic research programs by requiring specified Federal agencies to reserve a portion of their research and development funds for the replacement or modernization of laboratories and other research facilities at universities and colleges".

H.R. 2823 would establish a university research modernization program through six Federal agencies, including the Department of Health and Human Services. The bill would authorize appropriations totalling $470 million for fiscal year 1987 for the replacement or modernization of research facilities, of which $200 million would be for the Department of Health and Human Services. For fiscal years 1988 through 1996 there would be no specific appropriation authorizations, but each of the six agencies would be directed to reserve at least 10 percent of its appropriations for research and development awards to universities and colleges for infrastructure improvement (with lesser amounts permissible in case the amounts appropriated decreased from one year to the next).

We concur with the testimony before your subcommittee on July 30 of Dr. Bernadine Healy of the Office of Science and Technology Policy that, while there is a need to improve the physical infrastructure of the nation's research establishment, the Administration does not favor the approach of H.R. 2823. We are seriously concerned that setting aside 10 percent of our research and development appropriations over many years would divert resources from our critical research programs.

We are advised by the Office of Management and Budget that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

/s/ Margaret M. Heckler
Secretary

DON FUQUA, Florida, Chairman

ROBERT A. ROE, New Jersey
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JAMES H. SCHEUER, New York
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General Counsel
JOYCE GROSS FREIWALD
Republican Staff Director

September 12, 1985

Hon. James M. Beggs
Administrator
National Aeronautics and
Space Administration
Washington, D.C. 20540

Dear Mr. Beggs:

H.R. 2823, the "University Research Facilities Revitalization Act of 1985", has been referred to the House Committees on Science and Technology, Energy and Commerce, Armed Services, and Agriculture. The purpose of this legislation is "To assist in revitalizing the Nation's academic research programs through capital investments in laboratories and other research facilities at universities and colleges. To carry out this purpose, each of the major Federal research and development agencies shall establish and carry out a new university research laboratory modernization program, under which an amount equal to a specified portion of the funds available to the agency involved for research and development awards to institutions of higher education will be reserved for the replacement or modernization of such institutions' obsolete laboratories and other research facilities."

I am enclosing a copy of H.R. 2823 for your review and would appreciate your written comments, no later than October 15, 1985. The views and recommendations of your Agency will be helpful to the Subcommittee on Science, Research and Technology in its present consideration of this legislation. A series of hearings is presently scheduled for October by the Subcommittee.

Should you have any questions concerning H.R. 2823, please contact Dr. Ezra Heitowit, Staff Director of the Subcommittee at 225-8844.

Thank you for your cooperation. I look forward to hearing from you.

Sincerely,

Doug Walgren

DOUG WALGREN, Chairman
Subcommittee on Science,
Research and Technology

DW/pt
Enclosure

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

September 10, 1985

Reply to Attn of C:KHS:tsc

Honorable Don Fuqua
Chairman
Committee on Science and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

The National Aeronautics and Space Administration has reviewed the bill H.R. 2823, the "University Research Facilities Revitalization Act of 1985", and voluntarily submits the following comments on that bill.

The bill would establish a special pool of funds to finance the modernization and replacement of equipment and facilities in university and college laboratories through University Research Laboratory Modernization Programs to be established in six Federal agencies, including NASA. NASA would be authorized to receive an appropriation of $20 million in fiscal year 1987 to begin the program; thereafter, funds would be required to be supplied by NASA from its research and development appropriation. Beginning in fiscal year 1988, the amount of the funds to be provided by the agency would be the lesser of (1) 10% of the total funds identified for research and development awards to colleges and universities that year or (2) the difference between the sum of the total funds for research and development awards to colleges and universities in that year plus the amount of the set-aside pool in the previous year and the total funds for research and development awards to colleges and universities in the previous year. In addition, 15% of the funds set aside for this pool must be made available to colleges and universities which receive less that $2 million in government research and development funds in each of the preceeding two years.

NASA recognizes the significant problem of obsolete laboratory equipment within the university community. We also recognize that university research facilities modernization is important to the accomplishment of NASA's research program. NASA believes that progress is being made in this area by funding equipment and facilities modernization through our normal university research projects. Although the intent of the proposed legislation is worthy, the bill would place severe restrictions on NASA and would impact the accomplishment of our research mission. We would therefore oppose its enactment.

NASA obligated approximately $220 million to colleges and universities during fiscal year 1984. NASA does not identify a specific line item in the budget for sponsored efforts at universities or colleges. Rather, NASA determines its research programs for a given fiscal year and the amount of funding necessary for each program. The identification and funding of such programs are made on a mission-need basis (both for current, approved missions and future planning) and not in terms of the ultimate performers. NASA then determines those aspects of its mission which will be met by in-house capabilities and those parts to be conducted by outside organizations. Where the determination is for the work to be done outside the agency, the ultimate performer may be a university, industry, a non-profit organization, or another government agency. Of the $220 million obligated to colleges and universities during fiscal year 1984, approximately 10% or $22 million was spent on modernization and replacement of equipment used in support of NASA research. In fiscal year 1985 this amount is estimated at $25 million, and approximately $30 million is projected for this purpose in fiscal year 1986, based on the President's budget request.

NASA is very aware of the need to modernize university laboratory equipment and will continue to focus our efforts on the problem through our normal university research projects. We believe, however, that a new set-aside program, as proposed in H.R. 2823, would result in a decrease in funding to meet our research objectives without any concommitant benefit to university laboratories. Additionally, a separate approach to alleviating the problem through set-aside programs in numerous departments and agencies would increase overall institutional costs for administration and control.

The Office of Management and Budget has advised that, from the standpoint of the Administration's program, there is no objection to the submission of these comments.

Sincerely,

John F. Murphy
Assistant Administrator
for Legislative Affairs